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ABSTRACT

The primary goal of this practicum was to improve the mathematical thinking skills of preschool students in a class of 30. The practicum was also intended to help the teacher improve her skills as organizer and facilitator. Additional objectives were that: (1) students would score at least 50 percent on teacher-made tasks; (2) there would be no difference in scores of boys and girls on tasks designed by the teacher; (3) students' scores on an observable behavior checklist would increase; and (4) the teacher's performance in organizing and supervising students at play would improve. Activities included a 12-week program of free constructive play, training and supervision of the teacher, a parent workshop on fostering the development of children's mathematical skills at home, and the designing and pilot testing of a students' mathematics activity book. A mathematical thinking skills test that was designed by the teacher was given to target group students and students from a nonintervention control group before and after implementation of the program. The target group's scores improved by 40 percent, while the control group's scores improved by 18 percent. Data were collected by means of observations of the students and teacher of the target group. Results showed significant improvement. All objectives of the practicum were met. Appended are 30 references and related materials. (GLR)

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Developing Mathematical Thinking Skills in Pre-School Children Through a Programme of Free Constructive Play

by
Eugena L. Robinson

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Abstract

Developing Mathematical Thinking Skills in Pre-School Children through a Programme of Free Constructive Play.
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Descriptors: Early Childhood Education/Pre-School Education/ Early Childhood Mathematics/Mathematical Thinking Skills/Pre-School Teachers/Play/Constructive Play/Teacher Training/Sex Roles in Play.

The primary goals of this practicum were to improve the mathematical thinking skills of a class of 30 pre-school students. An additional goal was to help the para-professional teacher improve her skill as organizer and facilitator. Activities implemented included (1) a programme of free constructive play, (2) training and supervision of the teacher, (3) parents' workshop on developing mathematical skills in the home and (4) designing and piloting activities for a students' mathematics activity book. A teacher-made Mathematical Thinking Skills (MTS) test was pre-post tested on a sample of 16 students from the target group and 16 students from a non-intervention selected group. The target group improved its scores on the MTS by 40 percent while the selected group improved by 18 percent. This was a practically significant difference. Observation data were collected from the students and teacher of the target group and the results showed significant improvement. The writer's objectives were met. All instruments used and related materials such as sample pages from the mathematics activity book and the students' work are appended.

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E. L. Robinson

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CHAPTER I

Purpose

Background

The setting for the practicum was a pre-school situated in a small town in the Caribbean island of Jamaica. The school had an enrolment of 195 children in the age cohort three to five years. There were five classes housed in three classrooms. The largest classroom was partially divided by large chalkboards into three sections. In this classroom there were two five-year-old classes and one four-year-old class. The other two classrooms housed the three-year-olds and one other four-year-old class. The average class size was 30 children.

Chairs were adequate for all the children in attendance, but tables were insufficient. The classrooms were overcrowded with less than the national minimum of 10 square feet per child. Teaching-learning materials were grossly inadequate. Play equipment and teaching materials were made from cartridge paper and discarded materials called "trashables."

There was a canteen which supplied hot lunches for about 85 percent of the students. Lunch was funded through subsidies from the Ministry of Education and nominal fees paid by the students. About 15 percent of the children took a packed lunch to school.

Early childhood schools, except for infant departments and

infant schools, are community schools of basically two types: preparatory schools for children from a higher socio-economic status (SES) and basic schools for children from a lower SES. The study was concerned with the basic school children. The private sector, the churches, and other non-governmental organizations share responsibilities for the running of the basic schools. Several limitations create wide disparities in the quality of education offered in the basic schools - chief among these are the lack of space, materials, and storage facilities.

The majority of the children who attend basic schools are born to poor parents in poor settings where employment is subject to fluctuation, and income is low and irregular. The children who live and move in such settings display certain behavioural tendencies which have to be treated early if they are to grow up as functioning individuals (Grant 1986). "Initially, these children do not know how to play. They show a high degree of possessiveness for the purpose of depriving someone else of the use of a toy. They tend to imitate what others do" (p.ii).

Basic school teachers are by and large para-professionals with the exception of a small number of trained teachers. The age of the teachers ranges from 18 years to over 65 years. Most of the teachers in the age range 18 to 35 years made use of educational opportunities to improve their qualification, so that they could be better remunerated. The idea of having para-professional teachers at the early childhood level had to be examined from the

history of early childhood education in Jamaica.

Prior to the introduction of a systematized early childhood education programme in 1966, basic schools had been in existence from as early as 1938. They existed under various names and in various places. They bore the names of the churches, community centres, or districts where they were set up. Some schools were named after individuals, usually the teacher, and these schools occupied space in yards, rooms and on verandahs.

In general terms, basic schools could be regarded as the institutions with a programme intended to offer educational experiences to the children of the low or no-income family. Families were not usually put off by the accommodation as long as they had faith in the teacher. In 1967 a survey carried out by the Project for Early Childhood Education (PECE) showed that the majority of the teachers had very little schooling so they "lack the confidence and skill vitally important in providing meaningful experiences for young children" (Robinson, 1983 p. ii).

A survey conducted by the Ministry of Education in 1980 revealed that the percentage of trained teachers in the early childhood education programme was less than one percent. It was necessary, therefore, to train the teachers to improve the quality of education offered to those low-income children. The professional training for those para-professional teachers took place at regular fortnightly workshops conducted by the Ministry of

Education's appointed Teacher Trainers. A further 155 basic school teachers had been trained in a one-year intra-mural programme in a residential Teacher's College between January 1988 and December 1990. This was a specially internationally funded project called the North Coast Project (N.C.P.).

The programme offered to basic school students was a readiness programme which prepared them for formal learning at Grade 1 of the primary school. An integrated readiness curriculum was being used in the basic schools. Parents were anxious for their children to learn to read, write and do sums at an early age, so most parents saw play as a waste of time. The teachers in trying to 'please' those parents who paid fees for their children, often tried to ignore what was best for the children, and 'teach as they were taught.'

Theoretically, the method of learning through play was accepted by the teachers, but many of them were still not able to use this method to organize learning activities for their students. The main reason was a lack of physical space and a shortage of educational games in the basic schools. Most of the gadgets were made by the teachers from discarded materials so these sometimes lacked quality and durability. The belief existed among the parents that their children should read and write at an early age, therefore the teacher saw her role not as a facilitator, but as one who imparted knowledge.

Elkind (1988) saw this trend in early childhood education as constituting mis-education and "putting children at risk for short term stress and long term learning problems for no purpose" (p.86). Elkind emphasised that education was not a race and that there was no evidence that a child who was taught to read at the age of three had any lasting advantage over a child who learnt at age six or seven. "The benefits accrued only if the child showed an interest and asked for assistance" (p.86). However, healthy early childhood education is crucial for most children from low-income families, since the homes are less likely to produce the early stimulation so vital at this age.

If the problems which affect learning were not identified and tackled at the early childhood level then those problems would have taken on new dimensions and become national problems with each succeeding year of education.

The Problem

With the coming of Independence to Jamaica in 1962, came the awareness that education plays a very important part in nation building. Modern mathematics was introduced into the education system before teachers were adequately trained for this new approach. A concentration of the most qualified and competent teachers of mathematics was found in the 'best' urban schools. The failure to produce teachers who could teach mathematics resulted in the wide scale failure of students in the area of

mathematics.

The term mathematics had created fear in the minds of many students since the introduction of modern mathematics. Historically, the format of mathematics education in Jamaica was one in which paramount importance was originally placed upon arithmetic skills (Nissen, 1987). Arithmetic was a skill that was taught by the application of rules and rote learning. Thinking skills were not emphasized.

Nissen who cited a UNESCO report by Shaurd, said that under-achievement of large numbers of children in the area of mathematics was mainly because there was a strong tradition of learning by passive reception. If children were failing, then the fault rested with the method of training offered the teachers. This was the view of Nissen who carried out a diagnostic test on all students in the teacher training colleges. The subjects included classroom teachers who had returned to the college for a one-year Post Certificate course.

The test consisted of seventy five items all contained within the Ministry of Education's Curriculum Guide for use in Primary schools. Nissen reported that on some questions, fewer than 10 percent of the student teachers got the correct answer. "These results expose a general weakness on the part of the students in translating practical situations into the correct mathematics" (p. 12). The trend of high rates of failure continued at the

national level where the passes in the General Certificate of Education (GCE) and the Caribbean Examination Council (CXC) created cause for concern.

The entry requirements to the Teachers' Colleges and the Nursing Schools stated that students had at least a Grade 1 pass in mathematics at the Basic CXC level. Because those institutions were unable to find qualified students, they had to offer a one-year preliminary course to upgrade the students' qualification. Nissen stated that as much as 40 percent of the college graduates had continued to fail mathematics in the content areas.

The 1990 Grade 6 Achievement Test administered by the National Assessment Programme (NAP) revealed that the mean score for students on the mathematics test was 43 percent. Scores were as low as 22 percent on the higher level thinking skills. The continued dissatisfaction in the performance of students in mathematics in the primary schools led the NAP team to assess the readiness programme at the pre-primary level.

At the Grade 1 level, the students entering from the early childhood schools and a small percentage who attended no pre-school were tested on a Readiness Inventory in 1990. It was found that at the national level 40 percent of the students lacked readiness skills while 15 percent were minimally ready (Table 1:1).

Table 1:1

NAP Readiness Inventory

National Level (N = 46,048)

Grade 1 1990

%	Whole Group	Boys	Girls
Ready	44	41	48
Minimally Ready	15	15	15
Not Ready	40	44	37

The students were tested on nine readiness skills. The scores ranged from a mastery of 16 percent on auditory discrimination to a high of 63 percent on receptive language. Thirty three percent of the students showed non-mastery in number knowledge.

In the target area, the results of the Readiness Inventory continued along the same trend as at the national level, but at a lower percentage level. For example, at the national level 44 percent of the students tested were ready while in the target area readiness was 37 percent. (Table 1:2).

Table 1:2

NAP Readiness Inventory

Target Area (N = 2,394)

Grade 1

%	Whole Group	Boys	Girls
Ready	37	34	41
Minimally Ready	14	15	15
Not Ready	49	53	44

One very important finding was that the boys had consistently performed at a lower level than the girls. At the national level and in the target area, 44 and 53 percent respectively of the boys were not ready, while the percentage of girls not ready was 37 and 44 percent.

A lack of readiness skills at the pre-school level had serious repercussions at the primary level. Nissen (1987) contended that mathematics was a highly hierarchial subject in which the 'missing bits' were usually essential to an understanding of the next level of knowledge (p.8). The task of the teacher was to encourage the

child's thinking in his own way. Mathematical thinking at pre-school level was fully integrated in the readiness programme where all the readiness skills were equally important. An example of this was seen in listening comprehension, left to right orientation, visual perception-discrimination, and reception language which applied equally to mathematics and language arts.

For most teachers, mathematics at the early childhood level meant counting, concept of number and basic computation. The teachers lacked the competence to lead the students through the development of skills like exploring, observing, measuring, classifying, logical thinking, and problem solving. In the more financially able schools, mathematics workbooks were frequently used. The wide-scale use of workbooks appeared to be global. According to Granucci (1990) Smith reported from a survey of California teachers that the majority of pre-school teachers felt that if workbooks were taken away from them they would not know what to do.

Kamii (1982) did not believe in the use of workbooks. She saw workbooks as having little value since the comparison of ready-made sets was a passive activity in which the child was limited to only three possible responses - "The two sets were the same, one had more, or the other had more." (p.37). Kamii explained that children build concepts by reflective abstraction as they act mentally on objects. For example, a child who wished to build a

structure and could figure out how many blocks he needed was actually assimilating number words.

Based on these findings, the writer set out to investigate how a programme of free constructive play could develop mathematical thinking skills in pre-school children. The writer who taught "Understanding Mathematics in the Early Childhood Curriculum" to Basic School teachers in a one-year course at a teachers' college, was aware of the limitations that the teachers faced. The writer who had earned a Certificate and a Bachelor of Education in Early Childhood Education, had worked as a pre-school teacher, a Teacher-Trainer and an Education Officer in the field of early childhood and primary education for over 30 years. The writer was a Project Officer in the North Coast Project (page 4) and she also supervised U.W.I. B.Ed students in their practicum. She had recently written a monograph to help pre-school teachers understand mathematics for the young child.

In carrying out this investigation, a Basic Data (Appendix A:73) was used to find two teachers teaching in two schools with similar demographic characteristics. The target class was taught by a teacher who was a graduate of the North Coast Project. The teacher of the selected class was not a graduate. She received her training at inservice workshops. Both teachers were in the age range 36 to 45 years, they had been teaching for over 10 years and they were both headteachers. A family data form (Appendix

B:75) was used by the teachers to supply information to the writer about the students who would enter those classes in the new school year.

The target group consisted of a class of approximately 35 five-year-old students. Sixty six percent (66%) of the students were from single parent families, twenty five percent (25%) lived with both parents and nine percent (9%) lived with their grandmothers. (Table 1:3).

Table 1:3

Household Family Pattern of Students

Target Group

Family Type	Number of Students	Percentage
Mothers only	23	66
Mother and Father	9	25
Grandmother	3	9
Total	35	100

A record of the parents' occupation showed that 20 percent of the parents were unemployed, 40 percent were in low paid jobs, at or below the national minimum wage, 38 percent were intermittently or self employed as farmers, higglers and household helpers, while 2 percent were teachers, civil servants or business

personnel. (Table 1:4)

Table 1:4

Occupation of Householders

Target Group

Type of Occupation	Percentage (%)
Unemployed	20
Low income jobs	40
Intermittently or self employed	38
Professional and/or business	2
Total	100%

The writer observed the students to ascertain how well they had settled in school, prior to their entry into the target group. Although most of the students had spent one year or more in school, there were not many signs of gains from the effect of early stimulation. There was a lack of meaningful concrete experiences. Play materials were almost non-existent. The activities provided were insufficient, and there was nothing for the children to do when they became tired of one activity. There was no evidence of teacher-pupil interaction during free activity, nor was there any opportunity for the teacher to know what skills the students were learning. Teacher's time was usually spent in collecting lunch

fees or seeing to arrangements for lunch. Of greatest concern to the writer was the children who were not involved in any activities, and who were not spoken to by their teacher.

Based on these observations the writer designed a programme of activities which was geared to meet the needs of the teacher and five-year-old students in the target group.
The writer attempted to guide the teacher of the target group in organizing activities so that the students would acquire readiness skills and in particular mathematical thinking skills during free play. The programme was designed in keeping with the writer's specific objectives which follow.

Outcome Objectives

Based on the overall low performance of basic school students on the Readiness Inventory, the writer's objectives were as follows:

(1) Over a period of 12 weeks the students in the target group would score 50 percent or more on the teacher-made tasks designed to test students' mathematical thinking skills. (Appendix C: 77).

(2) Over a period of 12 weeks there would have been no difference in scores of boys and girls on the teacher-made tasks designed to test students' mathematical thinking skills. (Appendix C: 77).

(3) Over a period of 12 weeks the students in the target

group would increase their scores on a Child's Observable Behaviour (COB) Checklist. (Appendix D:90).

(4) Over a period of 12 weeks the teacher of the target group would improve her performance on the Performance Observation Schedule (POS) designed to test the teacher's skill in organizing and supervising students at play. (Appendix E:93).

A search of the literature revealed many theories and strategies which would help the writer to meet those objectives. These are documented in the next chapter.

CHAPTER II

Research and Solution Strategy

Development of Mathematical Thinking

The idea of changing classroom practices to enable pupils to develop their thinking skills is not new, but teachers are reluctant to put these ideas into practice since they are radically different from traditional practice (Goodlad, 1983). Raths et al. (1986) stated four overt conditions why thinking programmes had failed to make significant headway in classrooms.

The conditions were:

(1) Schools continued to buy and use workbooks which gave pupils extensive and exhaustive practice in the development of lower order skills.

(2) The dissemination of information where teachers did most of the talking and asked questions for pupils to ressurect information.

(3) Teachers were not trained to develop competence for thinking.

(4) There was an excessive reliance on standardized tests in which pupils showed their ability to recall what was taught. The authors further pointed out that children needed to spend many, many hours practicing higher order skills if they were to become successful thinkers.

Thinking, like listening, is crucial in the cognitive development of young children. More recently, educational innovations had turned to the learning theories to understand the nature of thinking among children. Gilley and Gilley (1980) referred to Jean Piaget, a Swiss, and B. Skinner, an American, as chief among the developmentalists. These psychologists agreed that formal education should begin as soon as the child has reached the level of learning readiness. However, they held different views on the manner in which learning takes place.

Piaget claimed that learning takes place within the child and that the child discovers for himself. His theory suggested that the child interacts with his environment through the process of assimilation and accommodation. On the contrary, Skinner was not concerned with what takes place within the child, but with how well the child reacts to stimuli to which he is subjected. Skinner believed that learning was facilitated by the teacher who planned activities in sequence to produce specific behavioural changes in the child.

Baroody (1987) looked also at two general theories of learning called the absorption theory and cognitive theory and their implications for mathematical thinking. The absorption theory which supported Skinner's views stated that knowledge was impressed upon the mind from without and it was viewed as a collection of facts which could be learnt by rote and fostered through the use of

reward or punishment. Absorption theory, according to Baroody stated also that children came to school as blank slates.

Cognitive theory, on the contrary, supported the views of Piaget and claimed that knowledge was worked out from within and it entailed understanding and meaningful learning by insights. Knowledge, Baroody said, was a problem-solving process in which the learner constructed knowledge through assimilation and integration by using previous bits of information.

Cognitive theory suggested that learning could be its own reward and children's natural curiosity enabled them to make sense of the world. The theory also stated that,

> Most young children readily abandon tasks that they find uninteresting. Yet when working at problems that interest them, children will devote considerable time - hours, and even days - to working towards mastery (p.12).

As a great proponent of cognitive theory, Piaget recognized an external and internal source of knowledge. Mathematical thinking belongs to the internal source of logico-mathematical knowledge. Kamii (1982) in supporting Piaget's views stated that teaching a child to count by calling number names was social knowledge since each language had a different set of words for counting, "but the underlying idea of number belongs to logico-mathematical knowledge, which is universal" (p.14). The fact that children do not conserve number before age five shows that number cannot be taught directly, and the child has to construct it for

himself by putting all kinds of things into several kinds of relationships.

When children are engaged in various types of construction, they are encouraged to make choices in weight, length, shape, size and quantity whenever they feel the need to do so. This is how mathematical thinking begins. All mathematical thinking involves relationships of increasing complexity.

In order for this natural development of thinking to take place, the school's programme should be carefully planned. No one type of programme, however, completely meets the needs of children or their parents. Although educational theorists place emphasis on different aspects of the pre-school child's education, all the different programmes and theories tend to be woven into an eclectic pattern which provides ample opportunities for the total development of the child.

At age 5, the child has entered what Piaget called the period of intuitive thinking. This is the time when thinking is based on perception. The child must be stimulated by rich experiences in manipulating things in order to develop thinking and reasoning skills. Several studies have been conducted to support the view that children improve their thinking skills during these activities Hirsch (1984); Almy (1982).

Raths et al. (1986) cited a study by Wassermann in which nine children with certain thinking-related behaviours, as identified

by their teachers, their peers and themselves, were set tasks involving comparing, classifying, criticizing and summarizing. At the end of the semester, these children had significantly increased their thinking scores at a 2 percent level.

The authors reported that Wassermann's theory was further tested by Berker in the use of an experimental and two control groups, each with 27 matched students. One control group was selected from the same group as the experimental group. The result showed that 24 of the students in the experimental group made gains of three or more points, while similar gains were made by only three students from the in-class control group. "Berker's study added support to the idea that when children with certain behaviours are helped to focus on assignments that involve thinking their behaviour changes" (p. 201).

Other studies also supported the value of activities for promoting thinking. Fennel's (1984) study involved 10 children working in pairs on a constructive play activity. The experiment continued for five days per week over a period of four months. Level 1 of the Metropolitan Readiness Test (MRT) was administered to the experimental and a control group. A barrier was placed between each pair of children working together. Child A constructed a configuration using various building toys which child B could not see. Child A then proceeded to describe the steps taken in order for Child B to reproduce the configuration. Discussion and

questioning were allowed but no visible communication or gesture was permitted. Upon completion of the task the barriers were removed and the subjects were able to compare their construction and make adjustments.

Level II of the MRT was administered as a post-test. The results indicated that although there was no significant difference between the control and experimental groups on the pre-test, the experimental group made significant gains on the post-test. Fennel explained that the exercise enabled the child to construct a whole, then mentally retrace the steps taken in order to communicate instructions to another child.

Language then had to be decoded back into action. Fennel (1984) made reference to Piaget's claim that for one to become conscious of an operation, one's thought must pass from the plane of action to that of language. Since language plays such a vital role in cognitive development, pre-schools should provide experiences that will foster language and cognitive development. The language of pre-school children will develop much more easily when they have something to talk about.

An abundance of constructive activities which allow children to talk formally with their peers provide opportunities for the development of communicative and social skills. The teacher who understands the students' experiential background will be better able to facilitate their learning because even inarticulate

expressions can be easily interpreted.

Understanding the Child's Experiential Background

The environment in which the child grows has a significant effect on his development. To a young child, life is most real in his home and among the people he knows, while school is often less real because what happens there is sometimes cut off from the life he knows at home.

The first five years are crucial years for the child. The child is deeply influenced during this period by the behaviour and attitude of adults, especially those in the home. Since this study was centred around children in the low-income bracket, the writer will examine certain factors which underscore the disadvantages in the lives of these children.

Grant's (1980) Caribbean Studies on home conditions have all pointed to poor living conditions, over-crowding and unemployment among the working class. The children of the target group were born in most cases, to young mothers whose early pregnancy denied them a complete secondary education. Knight-Johnson and Jarrett (1986) reporting on a Baseline Survey of Teenage Pregnancy found that 20 percent and 38 percent of teenagers became pregnant while attending All-age and Secondary schools respectively. Most of those teenaged mothers themselves belonged to families of low or no-income. Sinha (1988) cited a 1980 UNESCO report that 22 percent of Jamaicans were illiterate. Grant (1980) felt that it was

possible that some of those persons were lapsed illiterates.

The marginal education and low income of those parents coupled with an ignorance of parenting skills, contributed to the inability to provide early stimulation at home, or to expose their children to a variety of experiences. On arrival at school and even up to the end of the first year in school, it was observed that most of those children did not know how to play.

Grant (1974) in reporting on the living conditions of some basic school children, pointed out that these children "grew up

(i) deficient in the discrimination and recognition of speech sounds

(ii) inattentive to auditory stimuli, and

(iii) deprived of adequate language experiences" (p. 18).

The aggressive and destructive nature of many basic school children stemmed from the influences of home conditions. Robinson (1983) supported the view that pressures of life in most socio-economically disadvantaged homes prevented parents from being favourable models for their children. There was often a high degree of inconsistency in adult behaviour. The children who were fed and loved in one instance often became targets of, or an outlet for parental anger and frustrations soon after. The child's lack of security which resulted from such experiences, "sometimes gave way to seemingly, aimless and disruptive hyperactivity" (p. 38).

Irregular school attendance is common among many of the basic

school children who live with single parents. Mothers form the bulk of these single parents and who earn very low wages. Sinha (1988) commented on the role of women in the survival and quality of life of children. Two views were expressed.

One view focussed primarily on women's productive role in which it is assumed that children will benefit from women's increased earnings and from the greater control of women over the use of resources that their work can bring.

Another view was put forward by policy makers and researchers who were concerned with child-health, nutrition and development. This view assumed that women should devote themselves primarily to their reproductive and child-care roles.

Sinha epxressed the view that although these were conflicting roles, traditionally, Caribbean women have always combined both roles. "If for any reason it becomes impossible for mothers to render child-care service to their children, the task falls usually to other women and very rarely to men" (P.108). These substitute mothers, for the most part, were usually very loving grandmothers. In many cases, poverty and ignorance barred many grandmothers from offering to the children the training and care so vital at that period of their development. Sinha observed that this delegation of child-care responsibilities both on a temporary or permanent basis is a strong feature of Caribbean life.

Once these children have survived to the pre-school stage,

the quality of education offered becomes more important. Suitably trained teachers are crucial for the educare of these students, but most developing countries can ill afford to provide education at this level. A discussion of the role of teachers for pre-school children follows.

The Role of the Teacher

From the moment pre-school children arrive at school until they return to their parents, their lives are influenced by the early childhood teacher. The teacher's role is both a responsibility and an opportunity. It is an inspired teacher who will gradually introduce the pre-school child to new experiences and who will bridge the gap between home and school.

The teacher has specific roles if the students are to benefit from the effects of play. Teachers of young children are more like guides or facilitators who prepare the environment so that it provides stimulating, challenging materials and activities for the children (Roopnarine and Johnson 1987). The teacher observes to see what the children understand and then poses additional challenges to push their thinking further.

Gulley and Zohairi (1989) discussed research identifying four teacher-roles: observer, organizer, participant-leader and trainer. In their examination of the implications of those roles for teachers, Gulley and Zohairi state that:

> Serious attention should be given in preparing teachers

> for their part in their students' play ... Not only should teachers be trained to regard play as significant in the curriculum, but also to fulfill the various roles within roles which constitute one's totality as a teacher. How to draw back successfully from one role when the end has been attained, how to sustain several roles simultaneously or in close succession are skills which become part of every teacher's repertoire (p. 11).

The teacher's role in fostering mathematical thinking has to be carefully understood. Kamii (1987) explained that number is not directly teachable, therefore the teacher can indirectly foster the development of logico-mathematical knowledge through three perspectives. These are:

(1) the creation of all kinds of relationships through interaction with materials,

(2) the quantification of objects and,

(3) the social interaction with peers and teachers.

In making references to studies done by Greco and Meljac, Kamii explained that children, before the age of seven who know how to count well, do not necessarily choose to use the skill when asked to put out the same number as the researcher. Meljac's study further showed that "counting does not become a perfectly dependable tool for young children until the age of six" (p. 33).

According to Kamii, the teacher's role in teaching the logico-mathematical realm is to avoid both the reinforcement of the correct answer or the correction of wrong answers. This practice develops in the child the idea that teacher is the only source of knowledge, and the child learns to read the teacher's

facial signs of approval or disapproval.

An important role of the teacher is to promote children's thinking through the various levels of questioning. According to Becher (1983), Bloom showed that young children are capable of acquiring or processing knowledge and they can show levels of comprehension through explaining. Children can also solve problems, answer questions or perform tasks. They can analyse, synthesise and evaluate their activities through the "how," "what," and "why" of the teacher's questions.

While specific terms are far too advanced for young children, Becher contended that children are able to engage in thinking at each of these levels and they do so regularly on their own, through their engagement in play.

Lee-Lundberg (1985) saw the teacher's role as an observer and not one who tries to teach the children things which they can only learn through the privacy of their own mind. In any kind of construction, the true purpose of the children's activities is experimental. The teacher should accept the name that is given to the structure no matter how incongruous it may seem. However, language plays a very important role in concept formation, and it is the teacher who has to provide the mathematical language at the right time.

The teacher's role as an evaluator is vital in assessing the effectiveness of a programme and in improving the instructional

process. Johnson in Roopnarine and Johnson (1987) stated that the teacher is second only to the child as the central figure in the formative or process evaluation. It is the teacher who, in the short term, will determine whether additional activities or omissions are necessary.

Johnson showed how the teacher's role as evaluator differs according to the theoretical foundations on which a programme is based. In the Montessori model, for example, the teacher's evaluation requires highly observational skills. The results of the evaluation will not change the programme but it enables the teacher to assist the students in adjusting their patterns of activities based on their developmental levels. The teacher's role as evaluator in the Kamii and DeVries Piagetian model enables an adjustment of the programme to meet the developmental and learning needs of the child. How well the teacher carries out the roles stated above will depend to a large extent on the qualification, training and experience of the teacher. In many pre-schools, it is the para-professional teacher who carries out this role.

The Teacher as a Para-professional

The growth of the para-professional teacher in the Caribbean was the result of an innovative response on the part of educators. The increased awareness of the special training needs of young children led to the utilization of low-income persons as auxillary

personnel in early childhood institutions.

The Bernard van Leer Foundation (BVLF) Newsletter (1991) described the para-professional as:

> Someone who functions along side a professional, someone who extends or modifies the role of the professional, someone who adapts it to particular circumstances ... someone who has a complementary set of skills and knowledge and is able to function and achieve results in a variety of situations and settings where a professional might find it difficult to work (p.1).

Since basic shoools were community schools, the basic assumption was that the para-professional served as a link between the community and the institutions that work with the community. Para-professional teachers on a global scale were regarded as teachers' aides, but in the Caribbean and in many other developing countries those persons were teachers in their own right.

Grant (1982) stated the specific objectives of the Project for Early Childhood Education (PECE) for the training of the Jamaican para-professional teachers. Those objectives were:

(1) to teach the para-professional teachers how to help their pupils through the Experience Units to use language easily and clearly,

(2) to clarify and understand certain basic mathematical concepts,

(3) to develop certain problem solving and socialization skills, and

(4) to have a positive image of him/herself as a person and as a learner.

Since basic school teachers were prepared through in-service

training, and with very limited resources, it was by no means possible or practicable to offer the teachers the full course of teacher education which was necessary. For these reasons the early childhood training offered to the teachers could be regarded as unique when compared with nursery education in developed countries.

More recently in the North Coast Project (Chapter I) these para-professionals had a comparatively higher level of training but with limitations to the theoretical offerings because of the level of their educational background. The N.C.P. had made positive gains in removing the concept of the teacher as centre-stage performer to one of facilitator in the provision and use of the learning centres. This was achieved through the competency-based curriculum.

Para-professional teachers served as role models and leaders in their communities. While they did not replace professionals, they were in fact closer to the real needs and motivations of grassroot groups and to their ways of expression. The BVLF Newsletter, however, documented the fact that para-professionals did not gain automatic confidence from the communities but it was only after a period of time that they were able to increase the self-sufficiency and the confidence of the people.

The Newsletter further stated that "para-professionals undoubtedly get much satisfaction from their work in their own

communities, and can reach people 'outsiders' might not be able to reach" (p.4).

In summary, it could be stated that the success of para-professionals in the teaching-learning process was based on three essential elements:

(1) the ability and potential of the individual teacher

(2) the quality of the training programme and,

(3) the teacher's belief in the value of play.

As children play, they develop ideas and learn concepts. The teacher must, therefore, understand the value of play in order to provide time and materials for its use. The value of play will be discussed in the next section.

The Importance of Play in Mathematical Thinking

Children are constantly exploring and creating through the medium of play, and it is during these activities that they encounter mathematical ideas and concepts. According to McKee (1986) Erikson called the period from 3 to 7 years the Play Stage in which there is an intimate linkage of thinking, play and language.

Since the days of Froebel, most teachers have seen play as an essential ingredient in the early childhood curriculum. Educators have looked at the value of play, the development of play and also the types of play. Play has been linked to the different stages of child development. According to the theory of Piaget, the play

of infants progresses from sensori-motor activity to pretence or symbolic play at around 15 to 18 months. Children move through the stages of solitary and parallel play to socio-dramatic play, where terms like structured play and constructive play are used to describe the activities. Almy et al. (1982) stated that teachers influence the play of children by providing a physical and social environment that is conducive to play, and by responding to and participating in the play.

McIntyre (1974) believed that there is too much emphasis on structured play activities. She contended that spontaneous and structured play should be planned for in a balance that is unique to the needs of the children in each classroom. McIntyre believed that structured play denies the child the opportunity of manipulating and discovering similarities and differences in his own way. It follows then that constructive play will be more effective in helping the child to think and make discoveries.

A child can create his own playthings from any available material. For example, a wooden block instantly becomes a truck, a building or a gun. "Good equipment and playthings are open-ended and serve a dozen uses depending only on the imagination of the child who is using them" (McIntyre p. 11).

Constructive play is seen by Almy (1982) as a move away from play towards work. Based on research findings by Rubin et al., Almy stated that "constuctive play is the most common form of activity, ranging from 40 percent of all activity at 3½ years to

approximately 51 percent at 4, 5 and 6 years" (p. 20). Almy concluded that constructive play might be an outcome of an environment that emphasized the manipulation of objects.

Williams and Shuard (1982) explained that constructive play had its advantage in enabling children to build their mathematical concepts particularly through an understanding of spatial relations. It was the view of Williams and Shuard that the manipulation of the two and three dimensional materials enabled a child to visualize a construction and select the materials to carry it out. They believed that free constructive play could be followed by controlled activity with the teacher suggesting ways in which the materials could be used, or by setting constructive goals.

Early exploration with blocks is a useful approach to mathematical thinking. According to Hirsch (1984), Lee-Lundberg was of the opinion that one should neither over-estimate nor under-estimate what happened intellectually when children were building with blocks. The children were pre-occupied with branches of mathematics called topology and projective geometry. Topology allowed children to experience spatial relations while projective geometry was concerned with seeing objects from differing sides and angles. Constructive play enabled children to gain an understanding of spatial concepts which were not easily understood.

Mathematical thinking requires some basic understanding

of number concepts. In constructive play Hirsch made the point that children first come in contact with piles, sets and groups as they interact with materials. They get ideas of more, less, and same as, when they select materials. However, Piaget's theory explained that up to age 5, children were unable to seriate and conserve.

> Children have not achieved the full idea of number until they have synthesized in their own mind, the two ideas of grouping into sets (classification) and ordering sets (seriation), (Hirsch 1984, p. 45).

Play has traditionally been considered an important part of the curriculum of pre-school programmes. This is because it is thought to promote development in all the growth areas: intellectual, social, language and motor. Are sex roles attached to particular types of play? And do these different types promote or retard any of the growth areas in boys or girls? The writer will now examine some aspects of sex roles in play.

Sex Roles in Play

Through toddlerhood and the early pre-school years, McNamee (1983) noted that a gradual distinction emerged between the types of play of boys and girls. According to McNamee, Piers and Landau observed that children tend to model themselves after the real and idealized grownups of their own sex. During free play in school, the girls tended to dominate the home centre while the boys played with the blocks.

Greenberg (1986) who looked at the differences in the types of play equipment offered to both sexes at the beginning of pre-school, found that boys received toys that promote scientific and technological understanding. Outdoor toys like kites, boats and balls or even substitutes encourage exploration and experimentation with space, motion and direction.

On the other hand, Greenberg stated that "girls play" was great preparation for beginning reading and writing as well as the discipline that schools demanded. She further stated that all the manipulations with dolls and small toys - tying, buttoning, cutting and pastry, prepare girls to recognize small differences. This is crucial to the making of careful discrimination and verbal fluency. But, Greenberg felt that the loss to girls was enormous as they lack the skill in exploration and experiences for the development of spatial relations.

A review of the literature revealed many instances where it was found that young girls were more verbal, and that they matured at an earlier age than boys. It was also found that boys were more aggressive than girls. McNamee made reference to Piens and Landau who said that "aggression is a lifelong component of all play, learning and work. It is the force behind our highest achievement as well as our most terrible acts" (p. 18).

Research has shown that on tests of general intelligence, grammar and spelling girls scored higher than boys, and girls also

learned to read and count at an earlier age. However, boys had both greater visual-spatial and mathematical ability than girls. Schirrmacher (1960) stated that the difference between boys and girls was not a developmental one but rather an artifact of the school situation.

According to Schirrmacher, Mayer and Thompson found that female teachers displayed significantly greater disapproval with boys than girls. This is evident since the nature of "boys' play" does not fit in with what is considered to be normal classroom behaviour. Schirrmacher quoted from a research done by Lyles that "boys in sex-split classes made better progress in language, arts and mathematics when compared with boys in co-educational classes" (p. 10).

On the whole, the teacher should provide experiences which will allow each boy and girl to share in the same activities during these most vulnerable years of human development.

Solution Strategies

Based on the review of the literature, the writer used a quasi-experimental design with non-equivalent groups as the method of undertaking this research. A teacher-made pre-post-assessment of the students was made through the use of:

(1) a mathematical thinking skills test

(2) a students' observable behaviour checklist, and

(3) a teacher's performance schedule.

The writer designed a programme of activities which was geared to develop the mathematical thinking skills of the students in the target group. This activity was carried out over a twelve-week period.

The writer planned and executed other activities which could have been part of the solution strategies. These included:

(1) Participating in workshops in which the writer demonstrated to parents how they could help in the development of mathematical skills with their children at home.

(2) Visiting teachers' workshops and sharing experiences with the teachers and officers.

(3) Making a video tape for parents and teachers by demonstrating how children could develop mathematical skills during play.

(4) Designing and piloting an activity booklet for five year olds.

(5) Discussing and sharing experiences with colleagues and students in the North Coast Project.

The writer felt that if these strategies were accomplished then some positive moves would be made in getting more teachers to understand how children develop mathematical skills.

CHAPTER III

Method of Research

The incontestable belief of educators is that if early childhood institutions are to be successful, they should be built on the needs of the children and should serve as an extension of their world. This belief of educators seems to suggest that one of the ways of widening the pre-school child's experience is through the use of activiites. Activities ought therefore to be an integral part of the curriculum of pre-schools.

This investigation was aimed at comparing the mathematical thinking skills of a sample of students in two basic schools. During the period of implementation, a programme of free constructive play was undertaken in a class of five year old basic school children. In doing this, the writer sought answers to the following questions:

(1) Will there be a significant difference in the level of performance on the test of mathematical thinking skills between the target group and a selected group at the

   (a) beginning of the programme?

   (b) end of the programme?

(2) In the target group, will there be any difference between the performance of the boys and the girls at the

   (a) beginning of the programme?

   (b) end of the programme?

(3) Will the observable behaviour of the children in the target group show positive growth at the end of the programme?

(4) Will the teacher of the target group improve her performance at the end of the programme?

Definition and Measurement of Variables

1. Mathematical Thinking Skills (MTS)

This was a teacher-made pre-post test designed to test the level of the students' thinking skills. The test consisted of 40 items and was arranged in two parts.

Part A involved concrete operations in which the student manipulated objects to answer the examiner's questions. The tasks tested the students' ability to:

(a) compare different sizes

(b) reproduce a given pattern of identical shapes

(c) compare quantities in groups of objects

(d) Place objects in required positions and

(3) solve numerical problems.

Part B consisted of pictorial representations. Some items were extracted from the Mathematical Assessment Booklet of Scholastics Early Childhood Programme (1981). The student was required to respond to the examiner's questions by touching the correct pictures.

The tasks tested the students ability to:

(a) identify differences in size

(b) recognize common relationships

(c) match sets of related objects

(d) recognize shape and size attributes

(e) interpret pictures in sequential order

(f) match numerals 1 to 4 with appropriate sets of objects and

(g) identify the position of objects in the pictures.

The test was piloted on a small group of children and an adjustment was made to some items. Item 17 required the use of three keys instead of two. The third key served as a distractor in order to reduce the likelihood of the child picking the target key by chance. Items 25 to 31 were rearranged for more effective presentation. A score of one point was given for each correct response.

Details of the test are found in Appendix C: 77.

2. The Child's Observable Behaviour Checklist (COB) targeted on some particular behaviour of the students during their constructive play. The checklist focussed on social, manipulative and thinking skills. The items were stated in positive terms. Some items for this checklist were taken from Skills for Pre-school Teachers by Beaty (1988).

The teacher observed the students' behaviour during their play in the construction area, and placed a check mark (✔) for yes and (N)for no beside each item on each child's checklist. Observations

were recorded at the beginning of the programme (Week Two), at mid-point (Week Six) and at the end of the programme (Week 12). A score of one point was given for each item checked.

3. The Teacher's Performance Observation Schedule (POS) consisted of 25 items arranged in three sections.

Task A examined the teacher's ability to organize the class in meaningful activities.

Task B assessed how well the teacher was involved in the student's activities and

Task C recorded how the teacher promoted the development of thinking skills.

The items were stated in positive terms. Each item was given a maximum score of three points. The teacher received 1, 2, or 3 points depending on her level of performance. The teacher's score reflected a percentage of the total points of all the items on each task. The writer observed and rated the teacher during the second, sixth and twelfth weeks of the programme.

4. Sex of Child

In analysing the data a comparison was made of the performance of the boys and of the girls to see if there had been any significant difference between the scores.

5. The Samples

The samples consisted of two similar type basic schools in

fairly close proximity. An attempt was made to select schools and children in terms of a specific set of criteria so that a fair comparison of the children's thinking skills could be made. The criteria included the status of the school, and the social-economic status of the children.

A basic data of the teachers (Appendix A: 73) showed that both teachers were in the age group 36-45 years. They were headteachers with over ten years of teaching experience. The teachers had a few passes in the Jamaica School Certificate (JSC) but neither had passed English and Mathematics which were the qualifying subjects for them to receive additional subsidies from the Ministry of Education. The level of training the teachers received, however, was one major difference between them. The teacher of the target group was previously trained in the North Coast Project (page 4) by the writer. The teacher understood and practiced teaching in groups, which was necessary in carrying out this programme.

6. The Sample Students

Both the target and the selected class had approximately 30 students registered but attendance was rarely above 24. All the students in the target class participated in the programme but only a sample of the students was pre-post tested. Initially, it was intended to pre-test 20 students (10 boys and 10 girls) from each school so that given the possibility of sample decay, at least 18 students could be represented in the post-test.

During the period of post-testing only eight boys and eight girls who were pre-tested could be found in the classes. The sample was then reduced to 16 students. Inclement weather was responsible for the absence of several children.

Administrative Procedure

Before the collection of the data, letters seeking permission for students' involvement in the practicum were sent to the Education Officers in charge of the area in which the schools were situated.

Prior to the re-opening of school for the new school year in September 1991, the writer met with the teacher of the target group and planned strategies for the implementation of the programme. The writer assisted the teacher in providing activities for the construction centre.

The MTS pre-test was administered to the children individually in both schools during the first week of school September 2-6, 1991. A list of items used in the kit can be found in Appendix C: 77.

The test was conducted away from the classroom in a quiet place. The children co-operated fully by touching the pictures and manipulating the objects, but oral communication was almost void except for one-word utterances. The writer observed that the students' responses were spontaneous. There was no evidence that they gave much thought to the questions asked before they responded.

It took an average of 30 minutes to administer the test to each child on the first day, but the period was reduced to fifteen minutes afterwards. The teachers were unaware of what items were included in the test. The post-assessment followed the same procedure and was carried out during the period November 25 to December 3, 1991. This was a very rainy period and there were disruptions and absenteeism in the schools.

Implementation of the Programme

The programme of constructive play was implemented for a period of 12 weeks by the teacher of the target group. There were provisions for individual activities as well as small group interaction. Most activities were child-initiated while some activities were teacher-directed as seen in the time table Appendix F:96. The students were given opportunities to display and talk about their construction, and also to record their experience through drawing pictures and writing sentences.

The class was divided into three rotating groups, and each group was allowed 30 minutes in any one period in the construction centre. The classroom was arranged with the following learning centres: construction, dramatic play, language, sand, water, shopping. The construction centre which was the main focus consisted of activities which included: large building blocks for floor, smaller blocks for table top, colour and shape box, geo-boards, jig-saw puzzles, sand box and 'odds and ends' box.

These activities were placed in individual boxes and transparent plastic bags. Because of a lack of display space, some of the activities had to be kept in the construction box from which the children chose. This was unfortunate, since smaller activities were often overlooked by the children.

The writer visited the class once weekly and stayed for approximately two hours to observe and talk with the children. The writer also met with the teacher on Fridays to review the week's activities and plan new strategies. The tasks which took place over the 12-week period were set out in sequential order. The learning centres which were provided in this programme were suggested in the Ministry of Education's Readiness Programme designed for use in Basic Schools (Appendix G: 98). However, the level of emphasis and implementation of these learning centres in the schools vary from school to school.

The tasks which took place during this practicum are set out as follows:

Week One

The writer visited the target class on Monday and randomly selected 10 boys and 10 girls from the class register. Pre-testing started on Tuesday but there were only eight boys present. Twelve girls and eight boys were tested on the MTS. In the selected school, 10 boys and 10 girls were pre-tested. The writer randomly placed all the students in the target class into three

working groups and they received coloured tags of either red, green or yellow. There was no intervention in the selected school.

Weeks Two, Three and Four

Week two started with the first circle time. The students were introduced to the learning centres but the construction centre was highlighted. The students assisted in making rules for the care and use of the activities. The writer was present and assisted the teacher in this exercise. Because of the very limited space the students were permitted to take their activities to areas where they found space but the kits were to be returned to their storage places at the end of the activity.

The following activities were made available during the first three weeks:

(1) A junk box with odds and ends. The students explored, classified and experimented in their own way.

(2) Large building blocks of various sizes and shapes for construction on the floor.

(3) Small building blocks, cubes with letters and numerals for table top construction.

(4) Geoboards and rubber bands for students to explore shapes.

(5) Two-dimensional shapes - large and small triangles, squares and circles. The children explored and created

their own designs and patterns.

(6) Jig-saw puzzles - maximum of 6 pieces.

(7) Sand tray with various sized containers.

Teacher's Role

The teacher allowed the students to explore the materials freely while she observed their patterns of behaviour. By the end of week two, the teacher had completed Column 1 of the Child's Observable Behaviour (COB) checklist of all 16 students. The teacher encouraged free conversations and free movement within the construction area. The writer observed the teacher and rated her performance on the POS (Appendex E: 93).

Weeks Five, Six and Seven

The following activities were added to the construction centre:

(1) Three-dimensional table blocks: Students identified blocks according to length or height, built stairs, bridges, made repeating patterns.

(2) Unit blocks - one to ten, cubes: Students built structures and counted the number of cubes or units alongside them, then counted the cubes. The teacher's intervention was necessary at this point to ask open-ended questions and pose problems for the students to solve.

(3) Shapes and numeral templates: the students traced shapes on plain paper, coloured the shapes; cut them out and hung as mobiles.

(4) Task cards which consisted of patterns and shapes drawn on grid paper for use with geoboards: Patterns were graded - shapes were required to be made with one to three rubber bands. Initially, these were difficult for the children to follow.

Teacher's Role

The teacher guided the students by way of questions and encouragement in trying out other activities. The writer assisted the teacher in this area. During week six, the teacher observed and recorded the Students' Observable Behaviour on the COB (Appendix D: 90). The writer recorded the teacher's performance on the POS (Appendix E: 93).

Weeks Eight and Nine

Social studies theme for all schools was - Our Community.

(1) The students built their community with construction blocks, juice boxes and cardboards.

(2) Students built motor vehicles of their own choice from juice boxes - cutting wheels from cards and pasting on the correct number of wheels on their vehicles.

(3) Some students collected boxes, bottles and tins for the school shop.

Teacher's Role

The writer and the teacher took the students on a walk to observe structures in their community. The school was the focal point so the students looked at the shapes, sizes, and types of buildings near their school. The teacher guided the students to work out their own models of the school community. The teacher identified labels for the buildings on cards, and the students

identified the names and placed them on the appropriate buildings.

Weeks Ten and Eleven

Theme: Our Community (continued)

Topic: "Building a shop for the community." The students classified items according to type and size. They were allowed to arrange the goods on the shelves and they gave reasons why certain goods were placed on certain shelves.

Clocks - the students drew hands on the clock faces in order to tell what time activities began in the community.

Teacher's Role

The teacher gave the students every opportunity to construct the shops and arrange items in their own way. Questions from the teacher helped the students to make decisions. For example, "Are there enough sweets in the shop for everyone in the group?" "How much shall be paid for the sweets?"

The writer observed how well the teacher was able to guide the students in carrying out these tasks. Throughout the implementation, the writer gave guidance to the teacher - particularly in the areas in which she showed noticeable weakness.

Some of the teacher's weakeneses included her inability to

(a) Join in the children's play

(b) Stimulate the students' curiosity and

(c) promote different levels of thinking through questioning.

Activities continued into week 12 because heavy rainfall and flooding disrupted school for one week.

Week Thirteen

By using the teacher-made Mathematical Thinking Skills test a post-test (Appendix C: 77) on both the target group and the selected group, the writer conducted a summative assessment. The writer recorded the teacher's performance for the third time on the POS. The teacher recorded the students' behaviour on the COB. Some observations made by the writer over the period can be found in the writer's log Attachment 3.

The data were analysed to ascertain what gains had been made on the pre-test scores. The results are presented in the next chapter.

CHAPTER IV

Results

The data collected were analysed so as to provide answers to the specific questions posed by the investigation, and to ascertain how well the writer had achieved the stated objectives.

Question 1

Will there be a significant difference in the level of performance on the test of mathematical thinking skills between the target group and the selected group at the

(a) beginning of the programme?

(b) end of the programme?

Table 4:1

Means and Percentage Pre-Test Scores

Target and Selected Groups

	Target Group			Selected Group		
	N = 16			N = 16		
	Male	Female	Total	Male	Female	Total
Total Scores	119	142	261	120	150	270
Mean	14.87	17.75	16.31	15	18.75	16.87
Percentage	37.18	44.38	40.78	37.5	46.88	42.19

In Table 4:1 the scores indicate that there was no significant

difference between the scores of the target group and the selected group at the beginning of the programme. The target group gained a mean score of 16.31 while the selected group gained 16.87. The selected group showed a slightly higher score of 1.41 percent over the target group.

Table 4:2

Means and Percentage Post-Test Scores

Target and Selected Groups

	Target Group			Selected Group		
	N = 16			N = 16		
	Male	Female	Total	Male	Female	Total
Total Scores	256	260	516	170	216	386
Mean	32	32.5	32.25	21.25	27	24.13
Percentage	80	81.25	80.62	53.12	67.50	60.13

In Table 4:2 the scores at the end of the programme indicate that there was a substantial increase in the scores of the target group of 40 percent. In calculating the difference in the means and the standard deviation there was a difference of 1.12 which is of practical significance.

Figure 4:1 shows an overall performance of both groups on the pre and post tests.

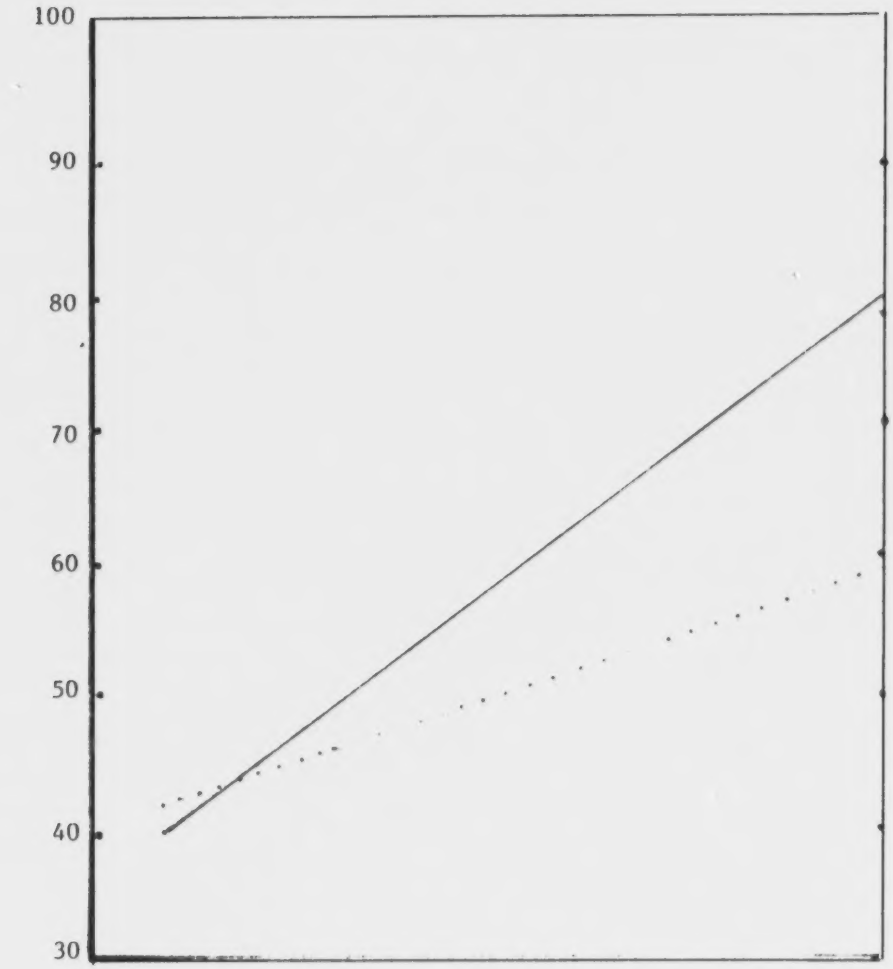

Figure 4:1

Pre-Test Post-Test Performance of Students

on the Mathematical

Thinking Skills

Question 2

In the target group, will there be any difference between the performance of the boys and the girls at the

(a) beginning of the programme?

(b) end of the programme?

Table 4:3

Pre-Test Post-Test Scores of Mathematical Thinking Skills of Boys and Girls

Target Group

	Boys (N = 8)		Girls (N = 8)	
	Pre-Test	Post-Test	Pre-Test	Post-Test
Mean	14.87	32	17.75	32.5
Percentage	37.18	80	44.38	81.25

Table 4:3 shows that at the beginning of the programme the girls in the target group scored 7 percent above the boys. At the end of the programme the boys had increased their scores and were only 1.25 percent behind the girls.

Question 3

Will the observable behaviour of the students in the target group show positive growth at the end of the programme?

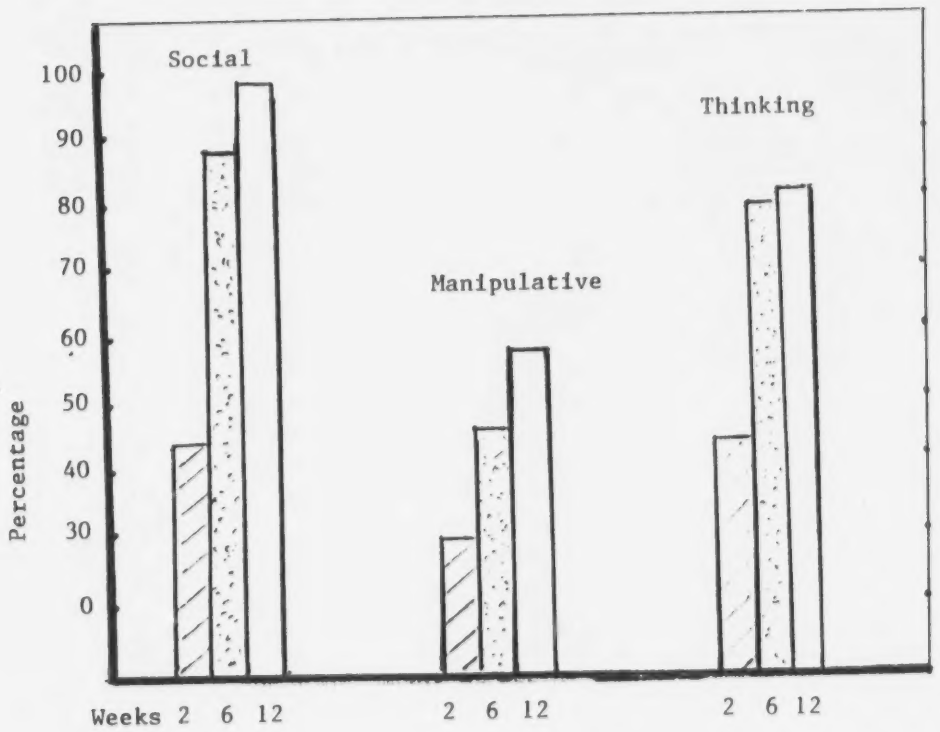

Figure 4:2

Scores of Students' Observable Behaviours

Target Group

Figure 4:2 shows that the students had improved their skills in the social, manipulative and thinking domains. The most noticeable improvement was in the social skills which moved from 53 percent to 99 percent. The lowest gains were in the manipulative skills which moved from 46 percent to 81 percent.

Question 4

Will the teacher of the target group improve her performance

at the end of the programme?

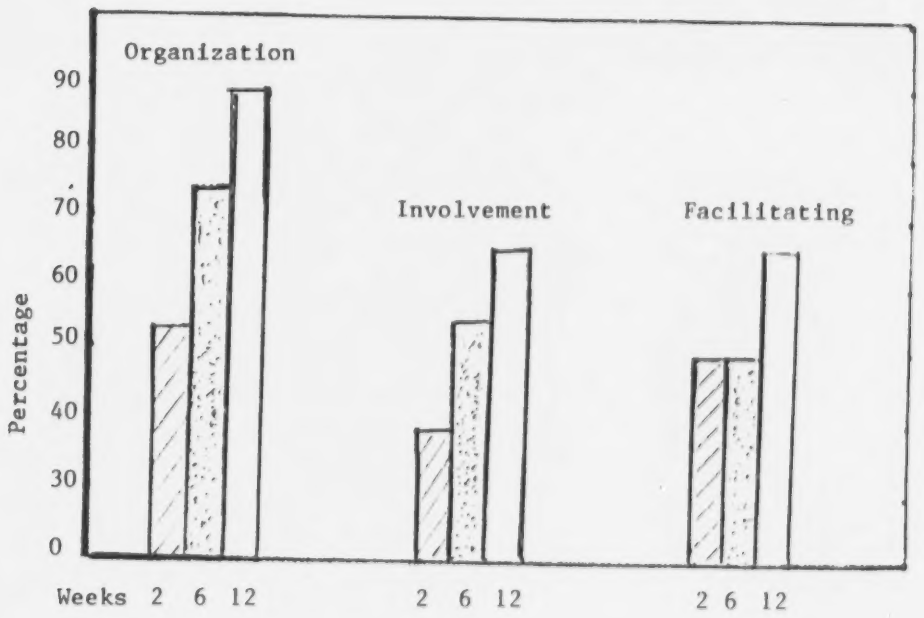

Figure 4:3

Scores of Teachers Performance

Target Group

The teacher improved her performance in all areas but most of all in the area of organization. The scores moved from 54 percent at the beginning of the programme to 91 percent at the end of the programme. Scores for involvement moved from 38 percent to 66 percent and for facilitating the students in the development of their thinking skills, the teacher's scores moved from 51 percent to 66 percent.

The data which have been presented show clearly that the writer had achieved all the objectives stated in Chapter I.

Objective 1

Over a period of 12 weeks the students in the target group would score 50 percent or more on the teacher-made tasks designed to test the students' mathematical thinking skills. The students substantially increased their scores from 40 to 80 percent.

Objective 2

Over a period of 12 weeks there would be no difference in the scores of boys and girls on the teacher-made tasks designed to test the students' mathematical thinking skills.

The boys increased their scores significantly and had almost equalled the scores made by the girls.

Objective 3

Over a period of 12 weeks the students in the target group would increase their scores on a Child's Observable Behaviour Checklist.

Graphs show that the students improved their behaviour in the areas of social, manipulative and thinking skills.

Objective 4

Over a period of 12 weeks the teacher of the target group would improve her performance on the Performance Observation

Schedule designed to test the teacher's skill in organizing and supervising the students.

The graphs show that the teacher improved her scores in all these areas.

Discussion

Some basic school teachers and their students worked under adverse conditions. Apart from inadequate space, many of the school buildings were also used for community activities.

At the beginning of the programme, the greatest problem was the lack of adequate space for the students who worked in the construction centre. It was obvious that many times they got into the way of each other but they managed somehow to sort out their difficulties all by themselves.

It was observed also that the teacher missed out on a number of specific pupils' behaviours because she was the headteacher and she was often called away from her class to attend to school matters. There was also a problem for the teacher to supervise all the students working in the three rotating groups. Whenever the writer visited the class, she spent her time with the students in the construction group where she observed and questioned the students about their activities. This was quite necessary as it was observed that some children abandoned certain tasks which seemed challenging.

The classroom was used by the church on Sundays for Sunday School. This meant that the teacher had to pack away most of her activities on Fridays then re-establish the centres again on Mondays.

The Students

Inspite of some of the problems mentioned, the students in the target group kept themselves busy and found ways of solving their problems. Their social interactions were good and they quickly learnt how to work together and share the materials which were available.

At the beginning of the programme, it was very difficult to get the students to complete one task before moving on to another. These negative social behaviours had changed rather quickly, however. Later, as the programme progressed a myriad of activities was carried out, and the writer observed that the students stayed in the construction area for as long as they were allowed.

The students became quite talkative. They all wanted the writer to look at their construction and to talk about what they had made. A little girl told the writer that she had constructed a barn. The writer was a bit puzzled because a barn was not familiar to the culture.

The conversation went like this:

Writer: "What is a barn?"

Child: "Don't you know a barn?"

"That is where you put animals."

Writer: "How many animals are you going to put in the barn?"

Child: "I do not know. I am going to fill it up. Then I will count them."

One little boy who had made long rectangular strips on the geoboard, said they were for race horses (paddocks). The writer asked:

"Where are the horses?"

Boy: "I am going to put them in." He then lined up some counters as horses, but the writer noticed that some paddocks were empty.

The writer asked: "Why have you put so many horses in that one?" He promptly responded, "Because I want to!"

The child's behaviour checklist was not meant to be used as a major tool of assessment in the study, but it was constructed to provide final quantitative data with which to create the summary graph. The writer's observation and the students' responses showed clearly that the students had benefited from the exercises. One positive sign was how well the children had become absorbed in their construction, and the visible change in their behaviour even when their teacher was out of the class. The children had moved from an egocentric to a sociocentric perspective as they exchanged ideas and helped their friends.

The Boys

Most tests given to pre-primary and primary students showed the boys gaining scores below the girls. This had become the norm where the girls were expected to do better. This study had proven otherwise. Research has shown that girls start school in a more favourable position towards learning than boys. In Chapter II reference was made to Schirrmacher who said that the difference between boys and girls was not a developmental one but rather, an artifact of the school situation.

In this programme, the boys were facilitated in their special interests and so the writer used their motivation to arouse their thinking. Both sexes shared equally in all the activities.

The Teacher

The teacher's scores ranged between 1 and 3 points. She organized the students in groups but she did too many things that the students could have done for themselves. For example, she gave the students their colour tags each morning, when the students could have helped themselves.

Her scores on the involvement and facilitating sections were below the writer's expectation. The writer observed that when the teacher had time to observe the students she hardly spoke to them. She intervened more frequently if the students disobeyed rules. The writer observed that the teacher had difficulty in wording open-ended questions. Although she provided opportunities for the

children to play,she seemed to lack the confidence or expertise to utilize the strategies involved. The writer spent most of her visiting times participating in the children's activities, posing problems for them to solve and encouraging exploration. These were the areas of greatest dificiencies observed in the teacher. But, it must not be forgotten that para-professionals have their limitations and their ability and potential vary.

The Selected Group

A selected group was used only during evaluations in order to make comparisons with the results of the target group. These children had scores slightly higher than the target group on the pre-test, but they had not maintained that lead on the post-test.

The writer observed that there were many inconsistencies in their responses on the post-test. Twenty two correct responses given by the boys on the pre-test were changed to wrong answers on the post-test. There were five such responses among the girls' scores. The children were noticeably quiet and withdrawn. They had to be coaxed into saying just one-word. This behaviour was quite the opposite to the period when they were pre-tested.

There was no replacement for their teacher, the oldest member of staff, who left the school during the pre-testing period. These children were displaced, and were supervised by either of the other two teachers. They spent most of their time with the teacher who taught the four year old children; and in a classroom

without learning centres.

The Mathematical Thinking Skills Test

On the whole, the test was a fairly reasonable one for five year olds. Few items were answered correctly by nearly all of the children - for example, items 1, 2, 3 and 18 in Part A. For items 15 all the children failed to put the mis-placed block in its correct place. The items which posed the greatest difficulty were the ones involving number concept. Although oral counting was correct, the students showed a lack of understanding of concepts like more, less, same. Guessing was evident in many of the responses. Many students correctly pointed to the sets which were more or less but only one boy in the post-test correctly said that two sets of 5 were the same. When asked which of the sets had more they all pointed to one of the sets of 5. When 3 stoppers were put in a paper cup, the students found it difficult to tell how many more stoppers were needed to make 5.

The students performed better on Part 2 of the test where they only had to point to the pictures. However, there were items involving spatial and positional relations which posed some difficulties for the students.

Item 32 required the students to "touch the duck that is last in the line." Most of them responded correctly by touching the duck on the left. The students must have observed the orientation of the ducks in the picture and showed their understanding of the

concept "last."

Limitations of the Study

The time allowed for this study imposed limitations on the (a) size of the samples, also (b) the extent of the supervision and training which could be given to the teacher of the target group.

The writer had limited time to test the students and so there was no time to probe the children's wrong answers in order to understand more about their thought processes.

Despite the limitations, the researcher is of the opinion that the results of the study are of significance and importance for the training of the teachers and for the implementation of the early childhood education programme. Based on these findings the writer makes recommendations in the next chapter.

CHAPTER V

Recommendations

The results of this investigation suggest implications for education and recommendations, which though offered with caution given the restricted nature of the research, could make a difference to what takes place in the early childhood classroom.

It is of practical significance to note that the target group which received less formal training, but which was more involved in exploratory play and more interaction with their teacher and peers, showed great gains on the mathematical thinking skills. This would indicate that formal teaching in mathematics may be less valuable at the pre-school stage.

The term free-construction is synomynous with child-initiated activity which should be central to an early childhood development curriculum. In view of the results from this study and the body of literature that stresses the importance of play, this writer suggests that a re-examination of the early childhood education training programme for Basic School teachers is needed. Training has to be intensified in the area of understanding mathematics.

Unfortunately, the majority of the early childhood education trainers are themselves completely biased towards mathematics. The teachers must understand that mathematical skills are learned through problem-solving where children are encouraged to think for themselves. Some of the best problem-solving materials in the

classroom are simplest to provide. They do not require hours of teacher preparation and they are good for the entire age range in the pre-schools. Blocks, clay or playdough, water and sand, and collage materials allow children to figure out what they need to learn.

According to Hirsch (1984) Lee-Lundberg in referring to the block-builder as a mathematican states that children's ability to compare one thing with another becomes a key to their mental or cognitive development. "One must, therefore neither overestimate nor underestimate what happens intellectually when children are building with blocks" (Lee-Lundberg p. 31).

This study has strengthened the writer's belief that Piaget's theory should form the basis of training the teachers in mathematical thinking. Piaget emphasized that much of the knowledge about number is not conceptualized until age six or seven years, which is outside the age range of the early childhood education programme in Jamaica.

Much of the failure and the dislike for mathematics among young adults stems from the effort of teachers to introduce children to abstract ideas before they can accommodate them. Raths et al (1986) emphasized that the teacher's role in promoting thinking includeslistening to students, encouraging open discussion, promoting active learning and accepting students' ideas.

Blocks for construction according to Hirsch (1984) provide

opportunities for integrative learning. Hirsch demonstrated that blocks contribute to physical development, mathematics, science, language arts, social studies, socio-emotional development and art. The blocks which are found in basic schools are not geometrically designed so there are limitations for the students to produce structures which are symmetrical and sequential. One benefit gained from the use of these blocks is that the children must figure out ways to build structures to remain standing or to make what they want when there aren't enough of a certain shape block.

Building models and securing them with adhesives is noticably absent in basic schools. Lower income children who cannot afford commercial toys, use their creativity to construct toys from discarded materials when they are out of school. The teachers need to encourage these types of construction within the schools and then use the students' experiences to develop their language and mathematical thinking skills.

The children in the target group were unable to tell how many legs two dogs have, or how many wheels were on two bicycles, but after they had constructed their trucks from juice boxes they were able to figure out how many wheels they needed to cut out.

Based upon the findings of this investigation, the writer proposes the following recommendations for implementation.

(1) Further research is recommended with larger samples and a wider range of activities to test the students' thinking skills particularly in conservation and reversibility.

(2) More indepth training in mathematics is needed for teachers where process is the focus and not the notions of correct and incorrect answers.

(3) More supervision is required for these para-professional teachers who need on-the-spot guidance in their roles as facilitators.

(4) Para-professional teachers should be required to supervise approximately 20 children if they are to work effectively.

(5) Parent programmes should aim more specifically in changing the parents' demand for formal education at the pre-school level.

Follow-On

The writer has written a monograph - "Understanding Mathematics in the Early Childhood Curriculum" - A guide for pre-school teachers. This guide aims at helping the teacher to understand that mathematics is more than computation, and that there are many exciting ways to help children develop their mathematical thinking skills.

The writer has also developed an activity book for pre-school children - "Mathematics can be fun." The writer's purpose was to create a workbook which is different from the usual ones on the market. The child will be required to undertake activities, (some of which will be done outside of the activity book) then record the results. In most cases there will be no one right answer.

Sample pages from this activity book are appended. It is the writer's intention to have this monograph and the activity book published for use in Jamaica's basic schools.

During the implementation of the programme, the writer conducted two workshops with parents of pre-school children. The theme of the workshops was "Teaching Mathematical Skills at Home." The parehts participated in activities that they could do with their children at home. They made games and other teaching-learning materials at the workshops. An audio-visual cassette was also produced.

The writer intends to share the experiences and the data collected during this study with the students in the North Coast Project, the teachers at the in-service workshops and colleagues in the Early Childhood Education Programme.

Baroody (1987) sums up the writer's experience in the following way:

> Mathematics need not be a meaningless and unpleasant chore that children are forced to endure ... By building carefully on children's practical mathematics, teachers can nurture the mathematical intelligence and curiosity that children bring with them to school and help children of all levels of ability to grow and achieve their potentials (p. 269).

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APPENDIX A

Teacher's Basic Data

APPENDIX A

Teacher's Basic Data

1. Name of School:.....
2. Name of Teacher:.....

3: Age group of teacher: ☐ 18-25 yrs. ☐ 26-35 ☑ 36-45 ☐ over 45

4. Teaching Exp. ☐ 1-5 yrs. ☐ 5-10 ☑ over 10

5. Present Teaching Position ☑ Head Teacher ☐ Assistant

6. Training Received: Workshop ☑ Course ☐ College ☑

7. Academic Record ☐ GCE ☐ CXC ☑ JSC ☑ Early Child-hood

APPENDIX B

Child's Family Data

APPENDIX B

Child's Family Data (Tally Sheet)
For children who will enter the 5 year old class in September

SES Pattern of Household	Number of children living in these households		
Family Intactness	Boys	Girls	Total
Father and Mother	IIII	~~IIII~~	9
Mother only	~~IIII~~ II	~~IIII~~ ~~IIII~~ ~~IIII~~ I	23
Father only	—	—	
Grandmother	I	II	3
Other			
Total	12	23	35
Family Size			
Under 3			
3-4	N/A	N/A	
5-8			
Over 8			
Occupation			
Small farming, Common Labourer, Higglering, Household helper	~~IIII~~ I	~~IIII~~ III	14
Factory worker	—	—	—
Self employed	IIII	~~IIII~~ III	12
Professional	—	II	2
Unemployed	II	~~IIII~~	7
Income level	12	23	35
Low income			
Middle income	—	—	—
High income			

APPENDIX C

Mathematical Thinking Skills Test

APPENDIX C

Mathematical Thinking Skills Test

Each item is given a score of 1
for a correct or reasonable
answer.

The examiner sits with the child in a comfortable place, asks the questions and waits for the child's response.

PART A

The examiner shows the child one large and one small teacup, one long and one short pencil. The examiner asks:

1. Show me the cup that is larger.

2. Show me the pencil that is shorter.

The examiner puts three shapes - triangle, square, circle in a row, and asks the child to:

3. Put your shapes in a row just like mine.

The examiner asks the child to use some counters to show:

4. How many legs one dog has?

5. How many legs have two dogs?

6. How many wheel one bicycle has?

7. How many wheels have two bicycles?

The examiner takes out ten counters - all the same size and kind, puts them in two groups and asks:

8. 2 and 8 - Which group has more counters in it?

9. 2 and 8 - Which group has less counters in it?

10. 5 and 5 - Which group has more counters in it?

The examiner counts out 5 stoppers in a row; covers 3 of the stoppers with a paper cup then asks:

11. How many stoppers are under the cup?

The examiner counts and puts 3 stoppers in a paper cup then asks:

12. How many stoppers must you put in the cup to make 5?

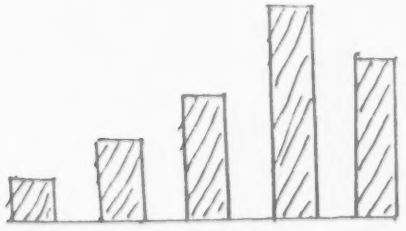
The examiner puts out 4 coloured blocks in a row and 3 toy cars in another row then asks:

13. Put the red car <u>on</u> the blue block.

14. Put the white car <u>under</u> the red block.

15. Put the green car <u>behind</u> the yellow block.

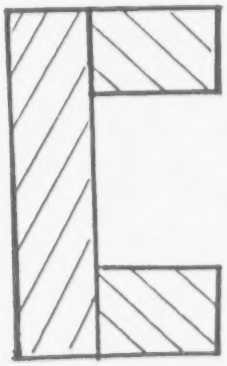
The student is shown 5 blocks arranged like this:



The examiner says:

16. I am building some stairs but block 5 is in the wrong place. Can you put block five in the right place?

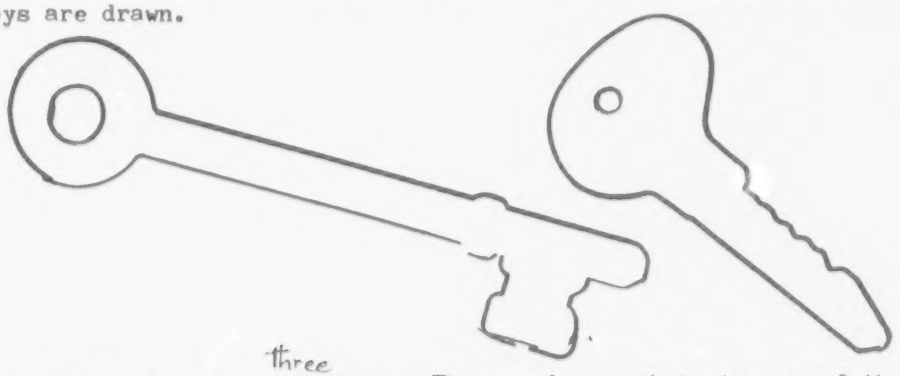
The examiner shows the student a card on which the following pattern is drawn.



The examiner asks:

17. Can you use these unit blocks to make a pattern like this pattern on the card?

The examiner shows the student a card on which the shapes of two keys are drawn.



The student is given ~~two~~ three keys. The examiner points to one of the shapes and asks:

18. Hold up the key that fits this shape.

PART B

The student will now look at the pictures to answer the following questions.

19. Touch the picture that shows the larger tree.

20. Touch the picture that shows the smaller dog.

Questions 21-24

The examiner touches a picture on the left and asks the child to touch the picture on the right which goes with the picture the examiner touches.

25. Touch the shape that is a square.

26. Touch the shape that is a circle.

27. Touch the shape that is a triangle.

28. Touch the shape that is a large square.

29. Touch the shape that is a small circle.

30. Touch the shape in the box that goes on the line.

31. Touch the shape in the box that goes on the line.

32. Touch the duck that is last in the line.

33. Touch the first thing that happens.

34. Touch the numeral that tells how many cars are in the picture.

35. Touch the numeral that tells how many birds are in the picture.

36. Touch the numeral that tells how many spoons are in the picture.

37. Touch the numeral that tells how many flowers are in the picture.

38. Touch the numeral that tells how many birds are flying away.

39. Touch the numeral that tells how many balloons the clown is holding.

40. Touch the numeral that tells how many sheep are in the pen.

PART B

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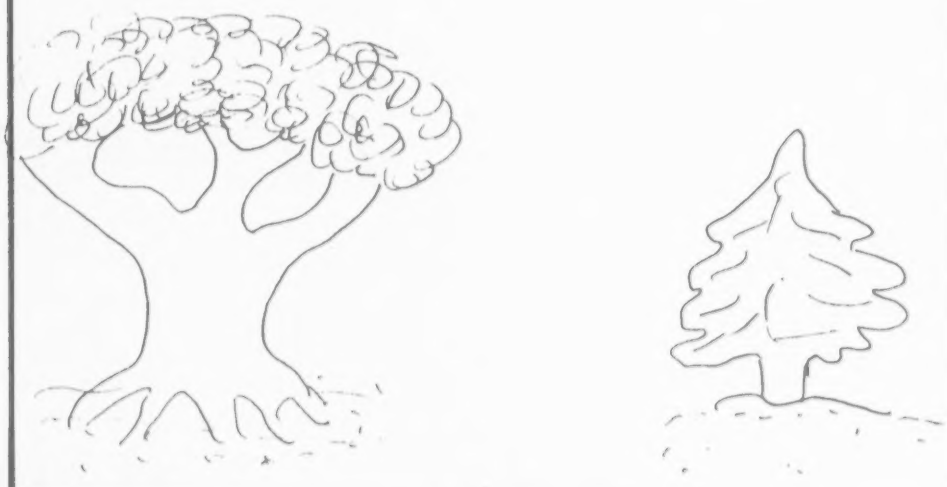

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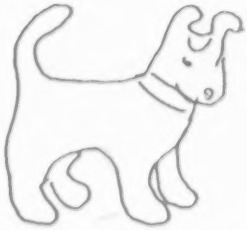

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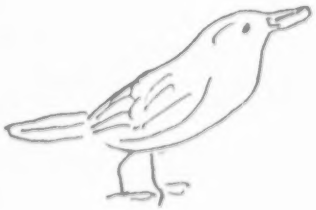

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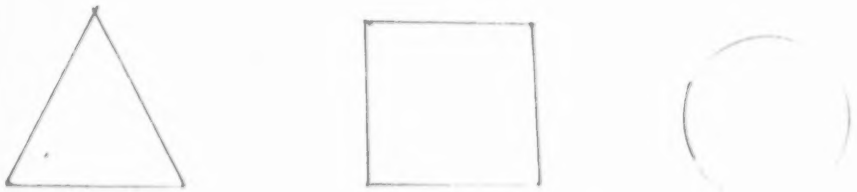

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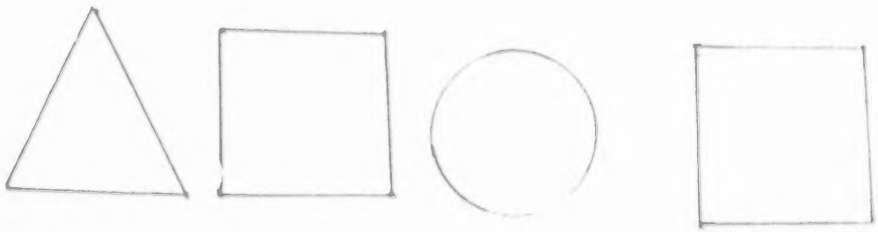

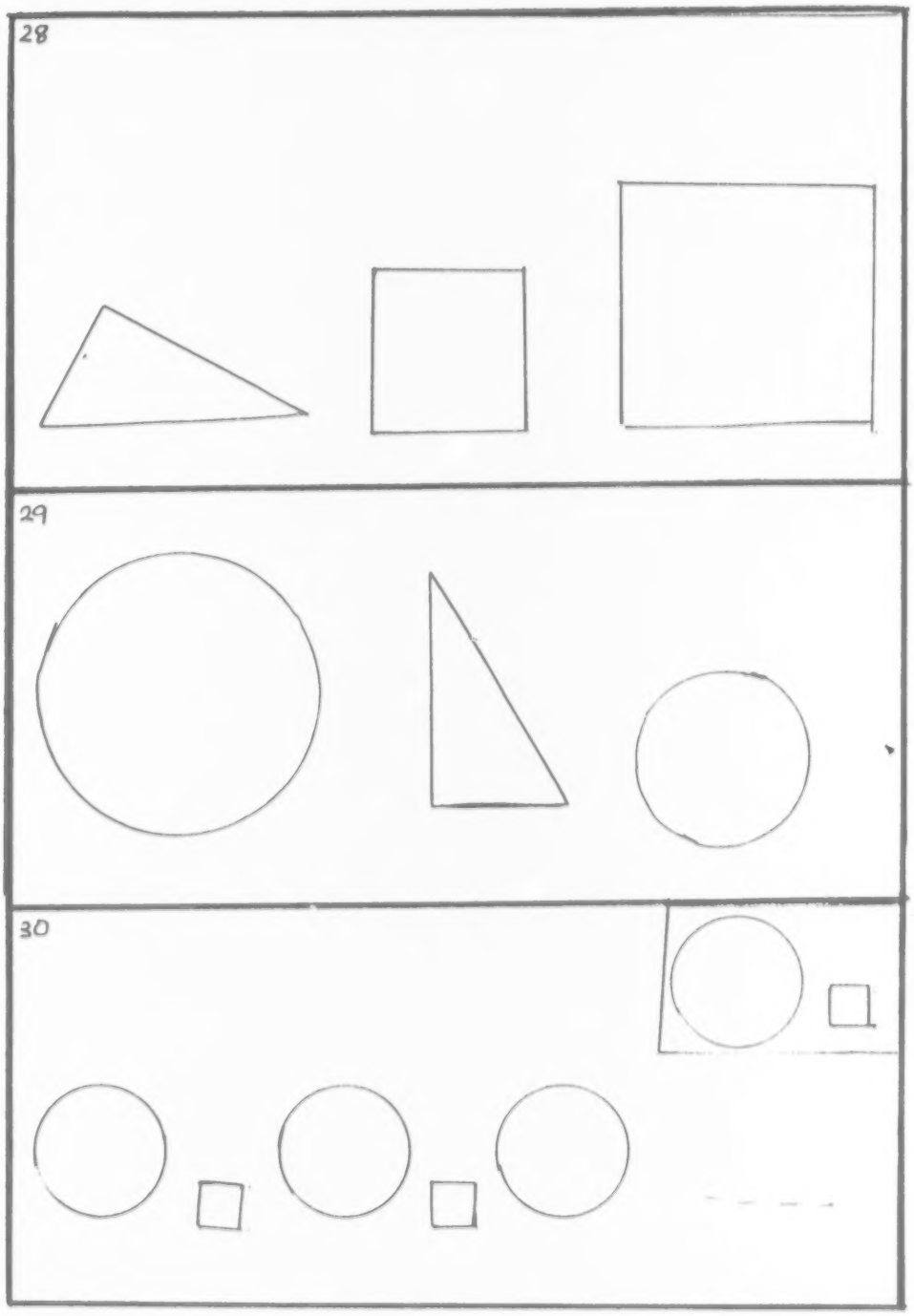
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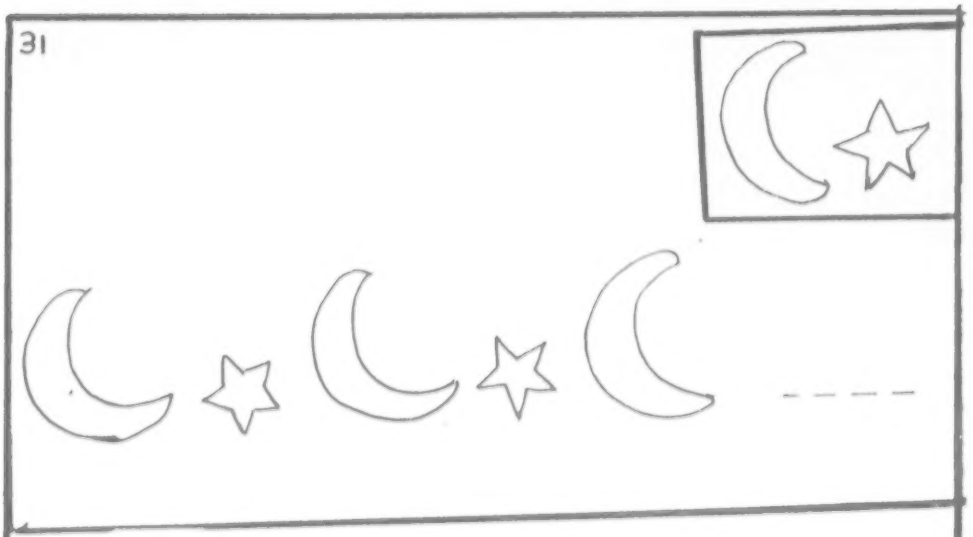

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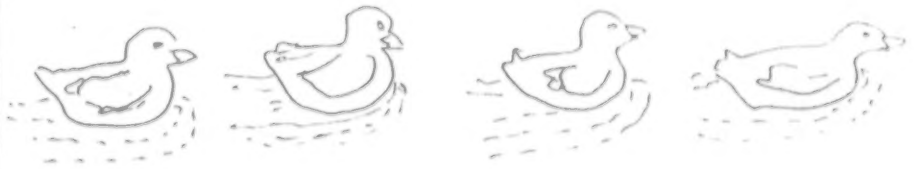

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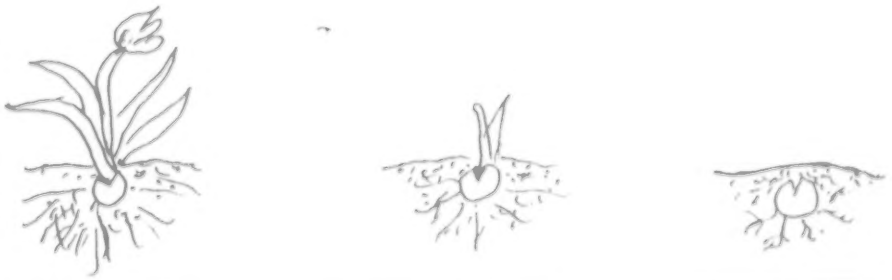

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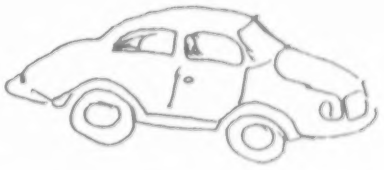

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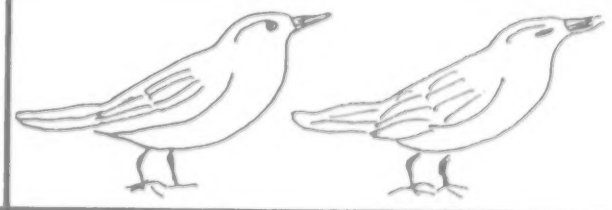

36

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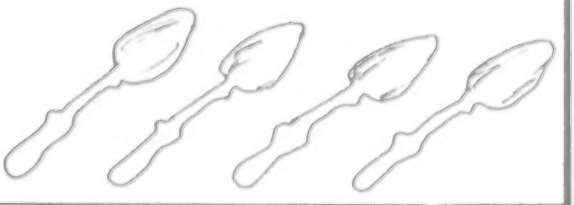

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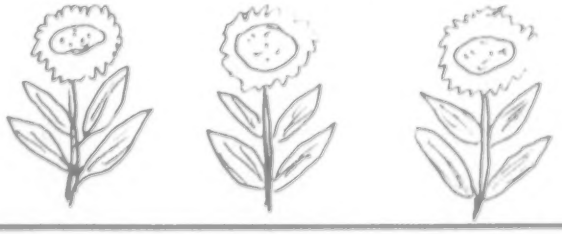
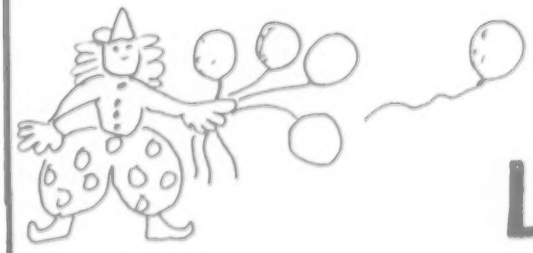


38

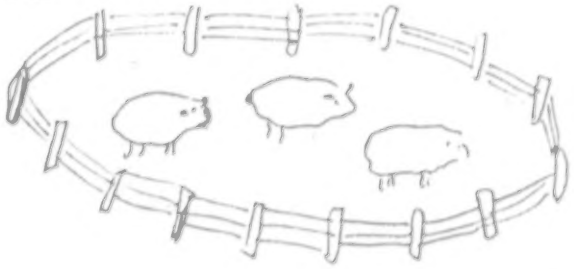
2 3 1

39



4 1 5

40



3
4
2

Mathematical Thinking Skills Test

Examiner's Kit

1. Two teacups - large, small.
2. Two lead pencils - long, short.
3. Two-dimensional shapes - triangle, square, circle (2 sets).
4. Ten counters all alike.
5. One paper cup.
6. Four coloured blocks - blue, yellow, red, green.
7. Three toy cars - white, green, red.
8. Five unit blocks - 1, 2, 3, 4, 5.
9. One pattern card (item 17).
10. One pattern card (item 18).
11. ~~Two~~ Three keys of different size and shape to match with number 10.

APPENDIX D

Student's Observable Behaviour Checklist

APPENDIX D

Student's Observable Behaviour Checklist

Name: Joye Davidson

(Put a tick (✓) for YES and (N) for NO

		WEEKS		
		2	6	12
	Social Skills			
1.	Chooses activity area without fuss	✓	✓	✓
2.	Stays with one activity long enough to finish it	N	✓	✓
3.	Builds in solitary manner	✓		✓
4.	Builds parallel to other students	✓	✓	✓
5.	Builds cooperatively with other students	N	✓	✓
6.	Is willing to share materials	N		✓
7.	Is willing to clean up	✓	✓	✓
8.	Shows respect for the models made by other students	✓	✓	✓
	Manipulative Skills			
9.	Handles objects with dexterity	✓	✓	✓
10.	Stacks objects with ease	✓	✓	✓
11.	Explores materials in areas	✓	✓	✓
12.	Records construction by drawing	✓	✓	✓
	Thinking Skills			
13.	Builds with a purpose	✓	✓	✓
14.	Selective in choice of building materials	N	N	✓

15. Counts materials accurately up to 10	✓		✓
16. Asks questions about materials	✓		✓
17. Does not copy other student's models	✓		✓
18. Describes model or object made	✓		✓
19. Shows understanding of likenesses and differences	✓		✓
20. Becomes absorbed in constructive work	✓		✓
Sorts materials accurately by			
21. shape	✓		✓
22. colour	✓		✓
23. size	✓	✓	✓
	19	22	23

APPENDIX E

Performance Observation Schedule

APPENDIX E

Performance Observation Schedule

Score: 1 - Inadequate
2 - Average
3 - Above average

	WEEKS 2	6	12
Task A: Organization			
1. The class is divided into subgroups.	2	3	3
2. The groups are constant.	2	2	3
3. All groups are always occupied.	2	3	3
4. The teacher gives clear instructions about what to do before breaking into groups.	2	2	3
5. The assignments to the groups are sufficient.	2	2	3
6. The time table is being followed.	2	3	3
7. The classroom space is effectively used.	1	2	2
8. The teacher does not do things the students can do for themselves.	1	1	2
Max. Score = 24	13	18	22
Task B: Involvement			
The teacher			
9. spends time with students in the learning centres.	1	2	2
10. seeks out lonely students.	1	1	2
11. plays with the students.	1	1	1
12. works along with students in clearing up and putting away materials.	1	2	2
13. interacts with the students to stimulate their curiosity.	1	1	2

14.	acknowledges quiet time.	2	3	3
	Max. Score = 18	7	10	12
	Task C: Facilitating			
	The teacher's questions			
15.	are carefully worded.	1	1	2
16.	promote different levels of thinking.	1	1	1
17.	require answers in complete sentences.	2	2	2
18.	allow the students time to think.	2	2	2
19.	encourages exploration.	2	2	2
	The teacher			
20.	listens to the questions children ask.	2	2	2
21.	responds to all the children's answers.	2	2	2
22.	poses open-ended questions.	1	1	2
23.	poses problems for the children to solve.	1	1	2
24.	provides opportunities for the children to explore with the use of their senses.	2	2	3
25.	allows for evaluative judgement and open discussion.	1	1	2
	Max. Score = 33	17	17	22

APPENDIX F

TIME TABLE

APPENDIX F

TIME TABLE

Approx. Time	Mins.	Monday to Friday
8.00	45	Free Activity - Assemble for Devotion Registration
8.45	30	Circle Time(Teacher- Directed) Conversational Skills
9.15	30	Group Activities Red Group - Free Constructive Play Blue Group- Other Learning Centres Yellow Group- Skill Training(Teacher-Dir)
9.45	30	Group Activities Red Group- Other Learning Centres Blue Group- Skill Training(Teacher-Dir.) Yellow Group-Constructive Play
10.15	45	Circle Time - Conversational Skills Snack Break & Outdoor PLay
11.00	30	Group Activities Red Group - Skill Training(Teacher-Dir.) Blue Group- Constructive Play Yellow Group- Other Learning Centres
11.30	75	Lunch Break - Lullaby - Rest
12.45 2.00	75	Games/Music/ Drama/ Nature Walk/Story Dismissal

APPENDIX G

Readiness Programme

Term 1

Ministry of Education

Early Childhood Education Curriculum Guide

5 Year Olds Term 1

Topics

Living Together in our classroom

- things in our classroom
- neighbours in and near our classroom
- caring things in our classroom
- caring for others in our classroom

Living Together

- in our community
- identifying things in the community
- dwelling houses and public buildings
- roads, parks and community centre
- recognizing weather in the community

Concepts

Non-Numerical

- Size - smaller than, larger than, alike same, different.
- Position - first, last, after, behind, before, above, beneath, below; up, down, top, bottom.
- Shapes - regular and irregular.
- Colours - red, green, yellow, black, blue.

Concept of Number.

- Numerals 1-5
- Making sets 1-5
- Combining sets 1-5
- Writing numerals 1-5

Skills

- manipulation, computation, listening
- visual perception, classifying, observing
- comparing, patterning, assembling and re-assembling

Attitudes

- being careful
- being responsible
- being polite
- using and replacing things in the right place
- helping others
- caring things (amenities) in the community

Activities/Learning Centres

- blocks, sand, home, nature, discovery, book, writing, community

ATTACHMENT 1

Score Sheets - Target and Selected Groups

✓ Pre-test
/ Post-test

TARGET GROUP BOYS

Items	PART A																	PART B																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
1 Kevin	✓	✓	–	–	–	✓	–	–	✓	–	✓	–	–	–	–	–	–	✓	✓	✓	–	–	–	–	–	✓	–	✓	–	–	–	–	–	–	✓	–	–	–	✓		12
	/	/	/	/	/	/	/	/	/	/	–	/	/	/	–	–	/	/	/	–	/	/	/	/	/	/	/	/	/	/	/	–	–	/	/	/	/	–	✓	/	32
2 Dean	✓	✓	–	–	–	✓	–	✓	–	–	✓	–	–	–	–	–	✓	–	✓	✓	✓	–	–	–	✓	–	–	–	–	–	–	✓	✓	–	–	–	–	–	–	–	–	12
	/	/	/	/	–	/	/	/	–	/	–	/	–	/	/	–	–	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	–	/	–	/	/	/	/	/	32
3 Danny	–	✓	–	–	–	–	–	–	–	–	–	–	✓	–	–	–	–	✓	✓	✓	✓	✓	–	✓	–	✓	✓	–	–	–	–	–	–	✓	–	–	–	–	–	–	–	11
	/	–	/	/	/	/	/	/	/	–	/	/	/	/	/	–	/	/	/	/	/	/	–	/	/	/	–	/	/	/	–	/	/	/	/	–	/	/	–	–	31
4 Duane	✓	✓	–	–	–	✓	–	✓	–	–	✓	–	–	–	–	–	–	✓	✓	✓	–	–	–	✓	✓	✓	–	–	–	✓	–	✓	✓	✓	✓	–	–	–				17
	/	/	/	/	/	/	–	/	/	–	/	–	–	–	–	/	–	/	/	/	/	/	/	–	/	/	–	–	/	/	–	/	/	–	/	/	–	–	–	–	26
5 Tomo	✓	–	–	✓	–	–	–	✓	–	✓	–	–	–	–	–	–	–	✓	✓	✓	–	✓	✓	–	✓	✓	–	✓	✓	–	–	–	–	–	✓	–	–	–	✓	–	–	13
	/	/	/	/	/	/	/	–	/	/	–	/	/	–	/	/	/	–	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	36
6 Kayeed	✓	✓	–	–	–	✓	✓	–	–	–	–	–	–	–	–	–	–	✓	✓	✓	✓	✓	✓	✓	✓	✓	–	✓	–	✓	–	–	✓	✓	✓	✓	✓	✓	✓	✓		23
	0	/	/	/	/	/	/	/	/	–	/	/	/	–	–	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	–	/		3
7 Sherri	–	–	✓	✓	–	–	✓	–	–	–	–	✓	–	–	–	–	✓	–	✓	✓	✓	–	–	–	–	✓	–	–	–	–	–	–	–	–	–	✓	–	–	✓	–		11
	/	/	/	–	–	/	–	/	/	–	/	–	/	/	–	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	–	24
Andre	✓	✓	–	–	–	✓	–	✓	–	–	–	–	–	–	–	–	–	–	✓	✓	–	✓	✓	✓	✓	✓	✓	–	✓	✓	–	✓	✓	–	✓	✓	–	–	✓	✓	–	✓	20
8	/	/	/	/	/	/	/	/	/	/	/	/	/	–	/	/	/	/	/	/	/	/	/	/	/	/	–	/	–	/	/	–	/	/	/	/	/	/	/	/	30
PRE-	6	6	1	2	–	5	1	4	2	1	3	–	2	–	–	–	3	4	8	8	4	4	3	3	3	6	7	1	3	1	2	1	3	5	2	4	4	2	2	3	114
POST-	7	7	8	7	6	8	5	8	7	1	8	4	7	5	2	7	6	8	8	8	7	8	8	7	7	8	8	6	8	6	5	5	5	6	5	8	6	6	4	5	25

✓ Pre-test
1 Post-test

TARGET GROUP GIRLS

Items	PART A 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	PART B 19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
1 Anna-A	✓	✓	–	–	–	✓	–	✓	–	–	–	–	✓	–	–	–	–	✓	✓	✓	–	–	–	–	✓	–	✓	–	–	–	–	✓	–	✓	–	✓	–	–	✓	✓		15
	/	/	/	/	–	/	/	/	–	/	/	–	0	0	/	/	/		/	/	/	–	/	/	/	/	/	/	/	/	–	–	/	–	–	–	–	–	/	–	–	24
2 Anna-K	✓	✓	✓	✓	–	✓	–	✓	–	–	–	✓	✓	–	–	✓	–	✓	✓	✓	–	–	✓	✓	✓	✓	✓	–	✓	–	✓	–	✓	–	✓	–	✓	✓	–	✓	✓	25
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3 Joye	–	✓	✓	✓	–	✓	–	✓	✓	–	✓	–	✓	–	–	–	✓	✓	✓	✓	✓	✓	✓	✓	✓	–	✓	–	–	–	✓	✓	–	✓	✓	✓	–	–	–	✓		23
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4 Carron	✓	✓	✓	✓	–	–	–	✓	–	–	✓	–	✓	✓	–	–	✓	–	✓	✓	✓	–	✓	✓	✓	–	✓	–	✓	–	–	✓	✓	–	✓	✓						24
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5 Janice	✓	✓	–	–	–	–	–	✓	–	–	–	–	–	–	–	–	–	✓	✓	–	✓	–	✓	–	✓	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
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6 Deirdre	✓	✓	–	✓	–	✓	–	✓	✓	–	–	–	–	–	–	–	–	✓	✓	✓	–	–	–	–	✓	–	–	✓	–	–	✓	–	–	–	–	–	–	–	–	–	–	12
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7 Shelly	✓	✓	–	✓	–	–	–	–	–	–	–	–	–	–	–	–	✓	–	–	✓	–	–	–	–	–	✓	✓	–	✓	–	–	✓	–	–	–	✓	–	–	–	–	–	10
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8 Calicia	✓	✓	✓	✓	–	✓	✓	✓	–	–	✓	–	✓	–	✓	–	✓	✓	✓	✓	✓	✓	✓	✓	–	✓	✓	–	✓	–	✓	–	✓	✓	✓	–	–	–	✓		26
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POST	6	8	8	8	3	8	8	8	8	0	7	7	5	5	5	6	8	8	8	8	7	7	8	8	8	8	8	8	5	5	5	5	6	4	7	5	6	6	4		240

SELECTED GROUP — BOYS

PRE – POST-TEST

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
Kavan	✓	✓	0	✓	0	✓	0	✓	✓	0	0	0	0	0	0	0	0	✓	✓	✓	✓	✓	0	0	✓	0	0	0	✓	0	0	0	0	0	0	0	0	✓	0		13
	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0		8
Travia	✓	✓	0	0	0	✓	0	✓	0	0	✓	0	✓	0	0	0	0	0	✓	✓	0	✓	✓	✓	0	0	✓	0	✓	✓	✓	✓	0	✓	0	0	✓	✓	0	0	19
	1	1	1	1	0	1	0	1	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	0	1	0	1	1	1	1	1	1	1		30
Le ford	✓	✓	0	0	0	✓	0	✓	0	0	0	✓	0	0	0	0	0	0	✓	✓	0	✓	0	0	0	✓	0	✓	0	0	✓	0	0	✓	0	0	0	✓	0		13
	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	1	0	0	0	0	0	0	1	1	0	1	1	0	0	1	0		14
Sheldon	0	✓	0	0	0	0	✓	0	0	0	0	0	0	0	0	0	0	✓	0	✓	0	✓	0	0	✓	✓	✓	✓	0	0	0	0	0	0	0	0	0	0	0		9
	1	1	1	0	0	0	0	1	1	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0		13
Courtney	✓	✓	0	✓	0	✓	0	✓	✓	0	✓	0	0	0	0	0	✓	0	✓	✓	✓	✓	0	0	✓	0	✓	✓	✓	0	0	0	0	✓	✓	0	0	✓	✓		20
	1	1	1	1	0	1	0	0	0	1	0	1	0	0	0	1	1	0	1	1	1	1	1	1	1	1	0	1	1	0	0	0	1	1	1	1	1	1			27
Dwane	0	✓	0	✓	0	✓	0	✓	0	0	✓	✓	0	✓	0	0	✓	0	0	✓	✓	0	0	0	✓	✓	✓	✓	0	0	0	0	✓	0	✓	0	0	0	✓		17
	1	1	1	1	0	1	0	1	0	0	1	0	1	1	1	1	0	1	1	1	1	0	0	0	1	1	1	1	1	0	0	0	0	1	0	0	0	0	0		21
Jason	✓	✓	✓	0	0	0	0	✓	✓	0	0	0	0	0	0	0	0	0	✓	✓	0	✓	✓	✓	✓	0	0	✓	0	0	0	0	0	✓	✓	0	✓	0	0		15
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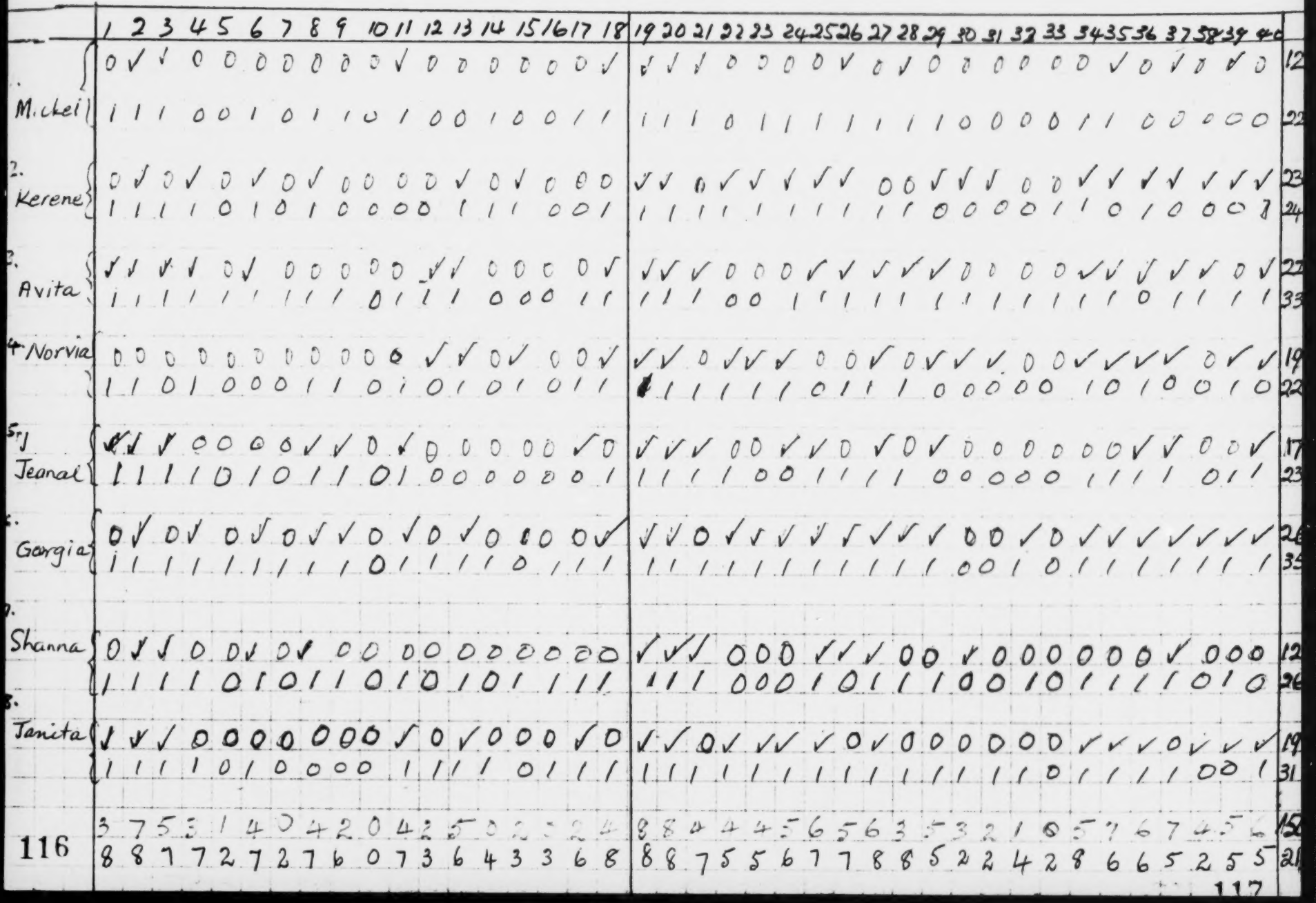
Andre	✓	✓	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	✓	✓	0	✓	0	✓	✓	✓	0	✓	0	0	✓	0	✓	0	0	✓	0	0		14
	1	1	1	1	0	1	0	1	1	0	1	0	0	1	0	0	1	0	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	0	1	0	1	0		21
PRE	6	8	2	3	0	5	1	6	3	0	3	2	1	1	0	0	3	2	5	8	4	5	3	3	4	3	6	4	6	1	1	2	1	4	3	2	3	1	3	2	120
POST	7	8	7	5	0	6	0	5	5	0	6	0	5	3	1	2	5	7	8	7	6	4	4	4	6	5	5	5	7	2	1	4	2	5	4	4	3	4	3	2	110

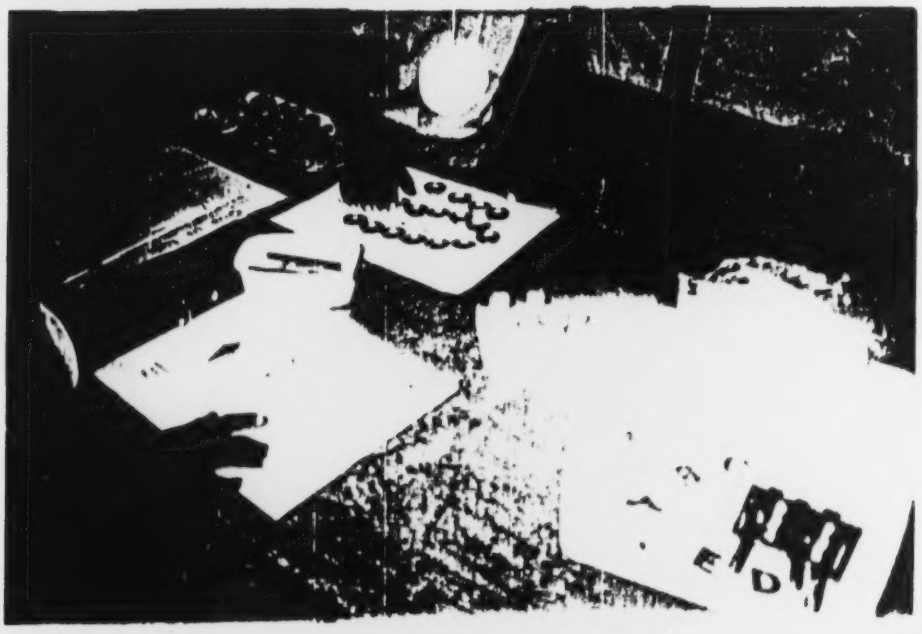
SELECTED GROUP. GIRLS

PRE-TEST POST-TEST



ATTACHMENT 2

Photographs - Some target group children
at play.



Piloting activities from workbook-

"Mathematics can be fun."

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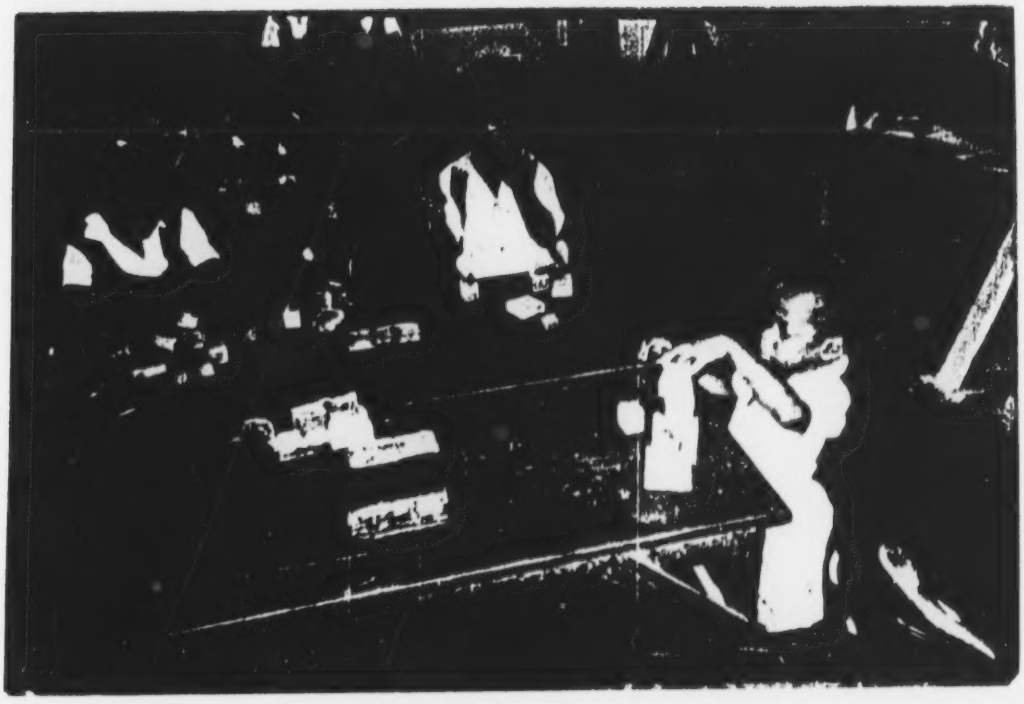

Watch me! See! I can make them balance!

We can do it too.

I am just thinking what to do with all these match boxes.

I construct my own shapes from templates.

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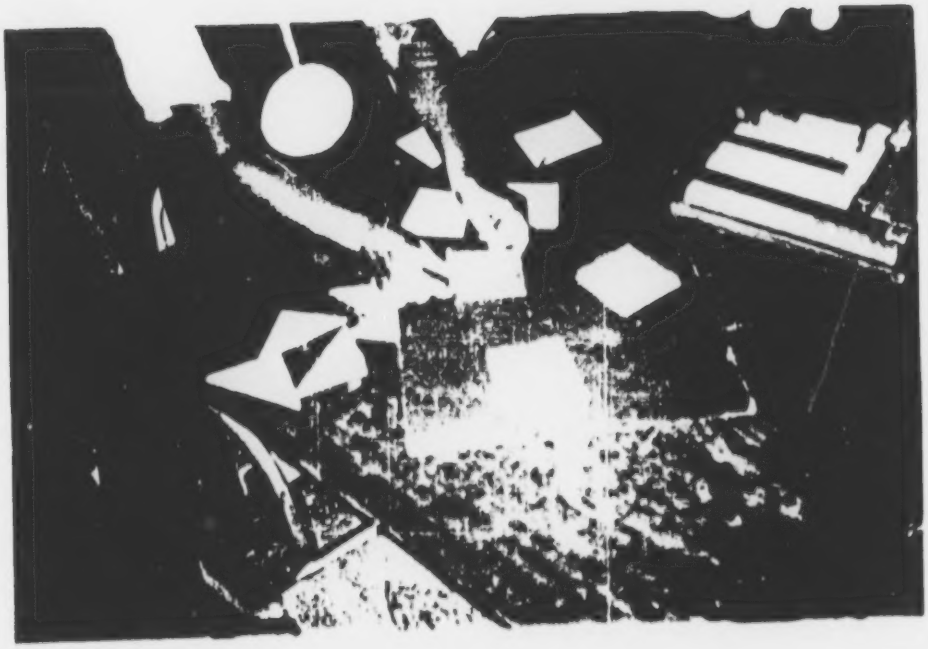
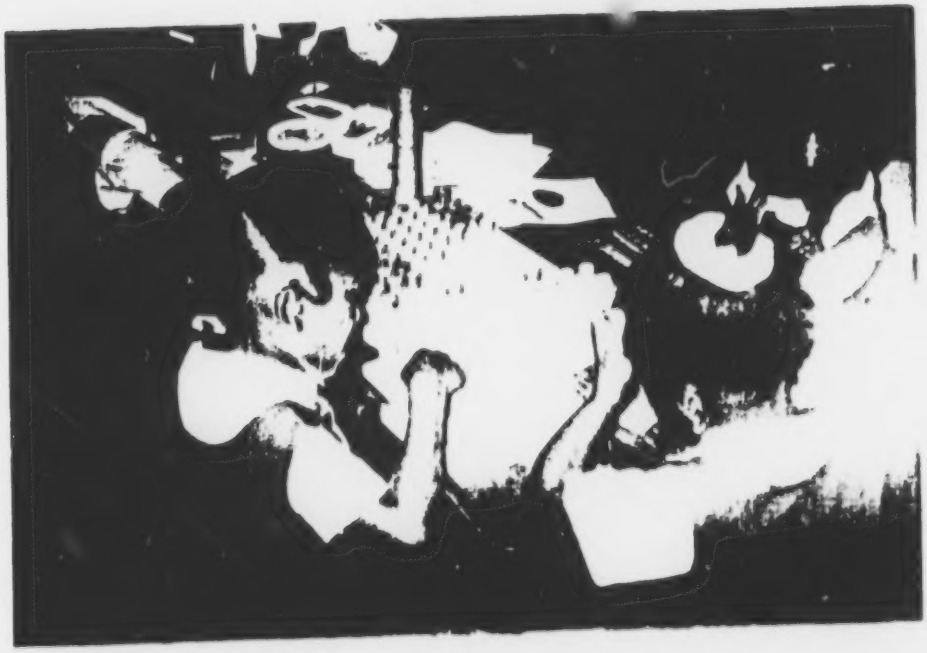


Two triangles make one square.



I can count all by myself.

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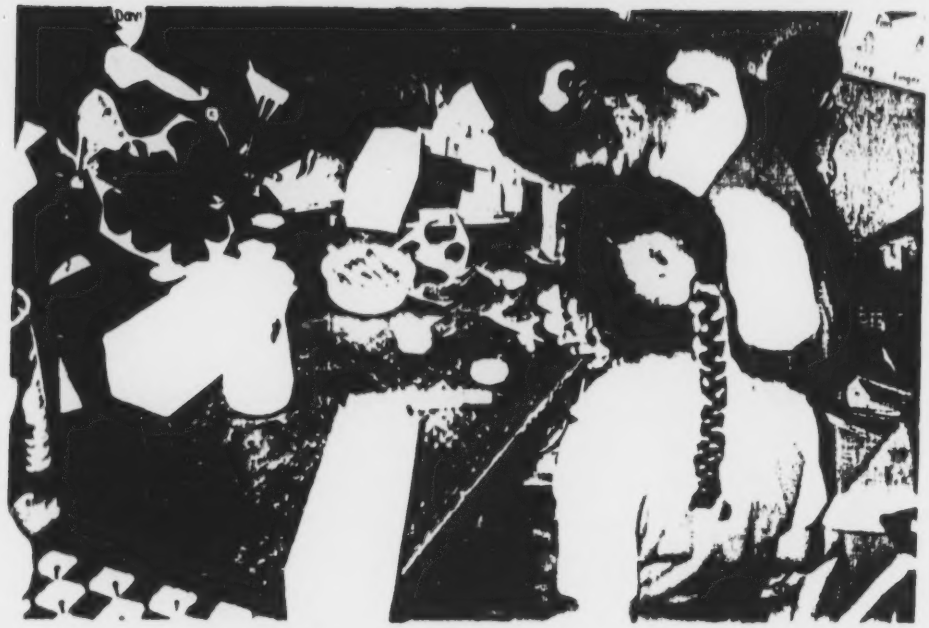


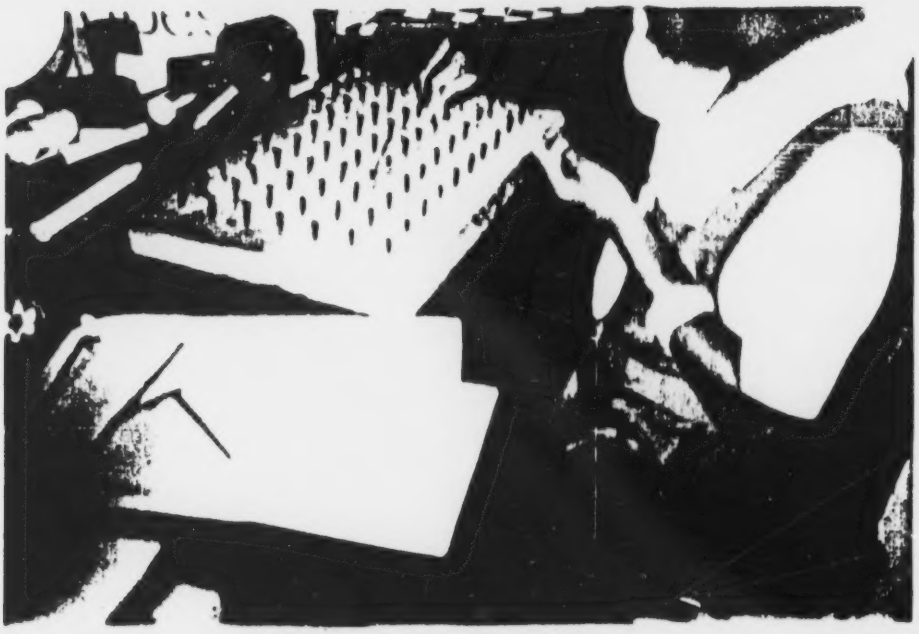
Trucks! Vans! Buses!

I need 2 wheels in the front, 2 at the back and 1 spare. I must cut out 5 wheels for my bus.

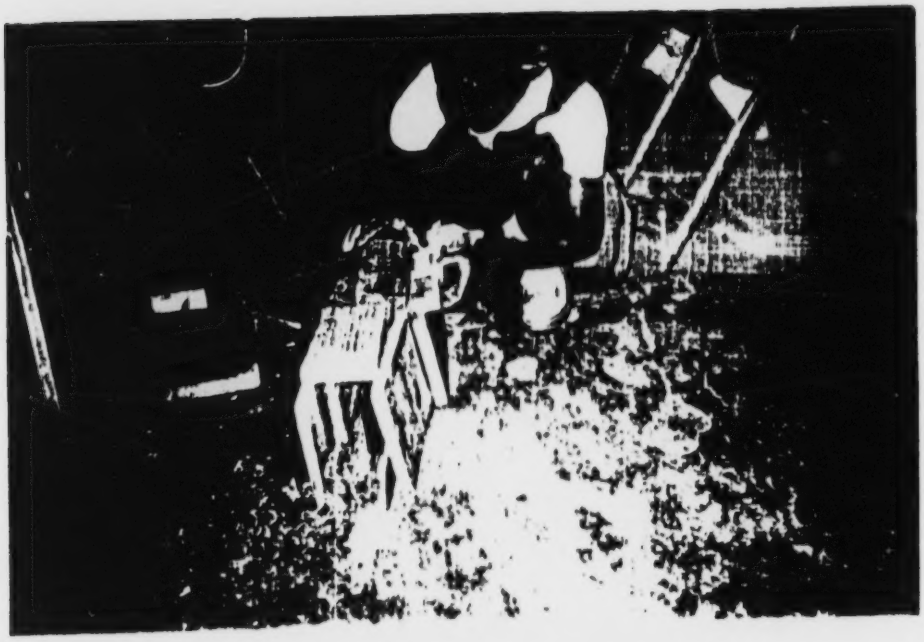
Now I will put my wheels on.

Co-operative Play

Thinking about our community. Where is the road?

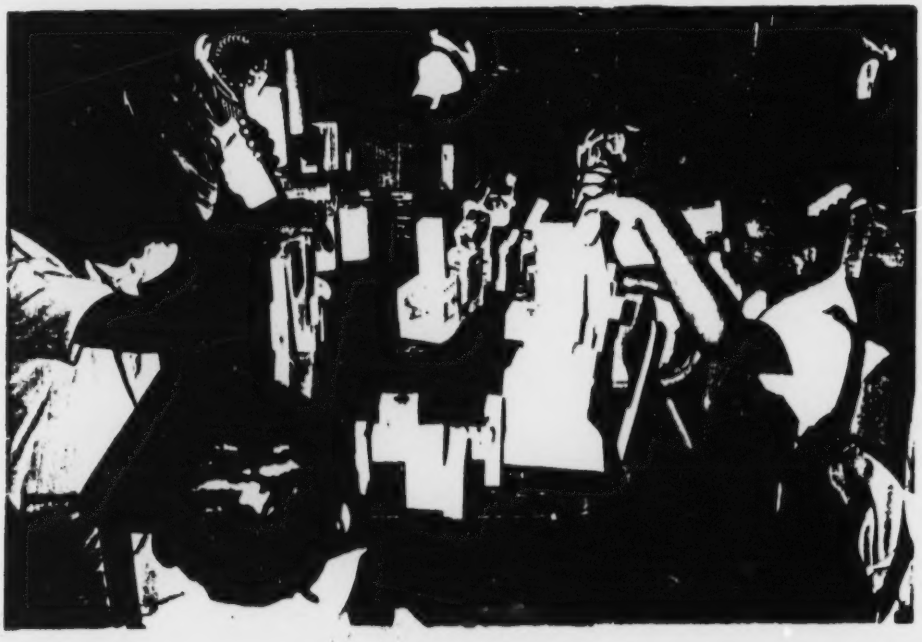


I am making triangles on the geo-board.



Solitary Play

Non-commercial blocks are sometimes very difficult to stay in place.



Parallel Play

A truck? A house? What will it be?

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ATTACHMENT 3

Writers' Log

L O G

First visit to the basic school - writer selects 20 children from the class register - 12 girls and 8 boys. The children are not settled - registration continues.

September 3, (Tuesday)
Pre-tests 14 children in the target group. Testing is slow. Work area is limited.

September 4, (Wednesday)
Pre-tests 8 children in the selected school. Assists target teacher in setting up learning centres in classroom. Teacher continues registration of new students. Students in target class are playing in the learning centres.

September 5, (Thursday)
Writer completes pre-testing of 12 students in the selected group.

September 6, (Friday)
Writer meets with teacher of the target group to plan strategies for week two. Children will be placed in three groups wearing colours red, blue, and yellow tags.

September 9, (Monday)
Writer visits target class. Teacher is absent for an hour to keep medical appointment. Writer distributes colour tags and sits with whole group on rug.

Writer introduces students to construction box. Activities in box are examined and discussion follows on the care of the activities. The class teacher returns. The students wearing the red tags move into the construction centre for free constructive play. Blue group works at a table with the teacher and yellow group plays in other learning centres.

The students in the constructive centre seem delighted, they want to try out all the activities. The box with odds and ends seems to hold their attention - Parallel play is evident among nearly all the students. The writer intervenes at times to get the students to put one activity away before attempting another. Everybody looks quite pleased. The writer remains for the morning session until all three groups have played in the construction centre. Space is limited. Students are getting in the way of each other.

September 12 (Thursday)
The writer visits. Rotation of groups is going well. Three girls are building co-operatively - "It is a big house", one said. The boys are building houses too, but it is parallel play. The teacher has completed the students' observation checklists (first column)

The writer has completed the first observation of the teacher. The writer meets with the teacher after school for discussion and evaluation.

Week 3 September 17 - 21,
The writer is unable to visit the school due to other pressing duties.

Week 4 September 24
School is closed for two days (Tuesday and Wednesday) because of lack of water. School resumes on Thursday. The writer meets with the teacher on Friday.
There is a change in strategy. The teacher will have free rotating play among all 3 groups for two days each week. This allows the teacher more freedom to observe.

Week 5 - September 30,
Monday - the writer visits. Students are sharing materials and there is much interaction. Students are spending time to complete their tasks. Group rotation is smooth.

Weeks 6 and 7 October 7 - 16,
Writer observes teacher and checks responses on the checklist.
The teacher records responses on students' checklists. Some children find folding paper into small squares and triangles difficult..
Girls build elaborate and complex block structures not much variation on geo-boards - they copy each other.

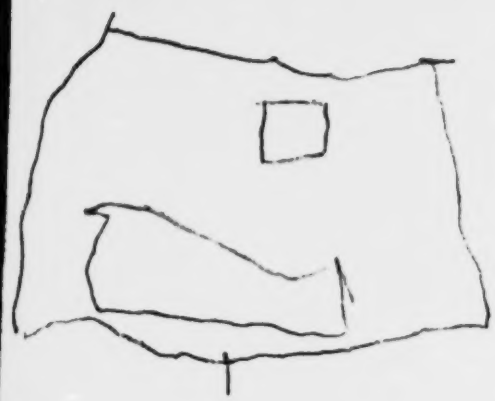
Weeks 8 - 10 October 21, 29, November 4,
Field trip - students are excited - they identify buildings - good knowledge of direction.
Model of community was dismantled - writer is disappointed that children have to start from scratch to rebuild instead of expanding.
Teacher lacks initiative - heavy rainfall and flooding - most students were absent for all of week ten. Post-testing will be delayed for one week.

Weeks 11 and 12 November 18,
Activities continue in learning centres. Some children are pilot testing activities for "Mathematics Can be Fun" activity booklet.
Writer discusses problems with teacher and records some instructions.
The children love the activities - those who were not given the activities are asking - "When am I going to do mine?" Writer takes photographs of students at play.

Weeks 13 November 25 - 30,
Post-test in target and selected school. A feeling of accomplishment.

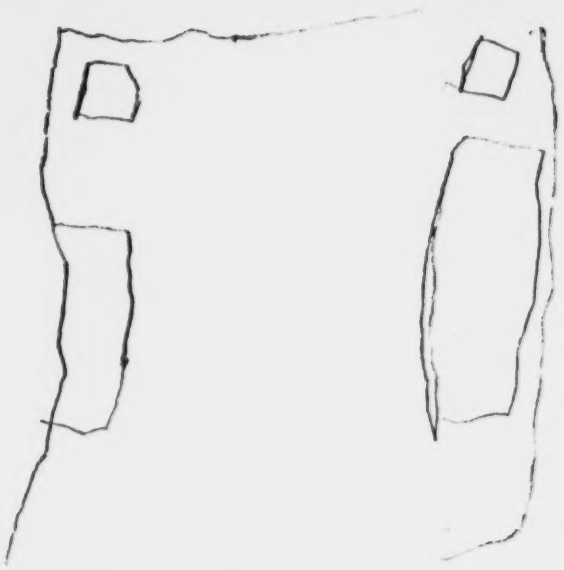
ATTACHMENT 4

Childrens' Pictures of their Construction



Baby's Clinic

The clinic is near the market.

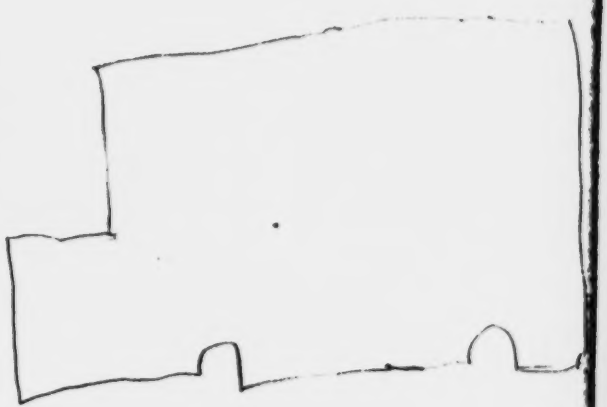


Mother's house

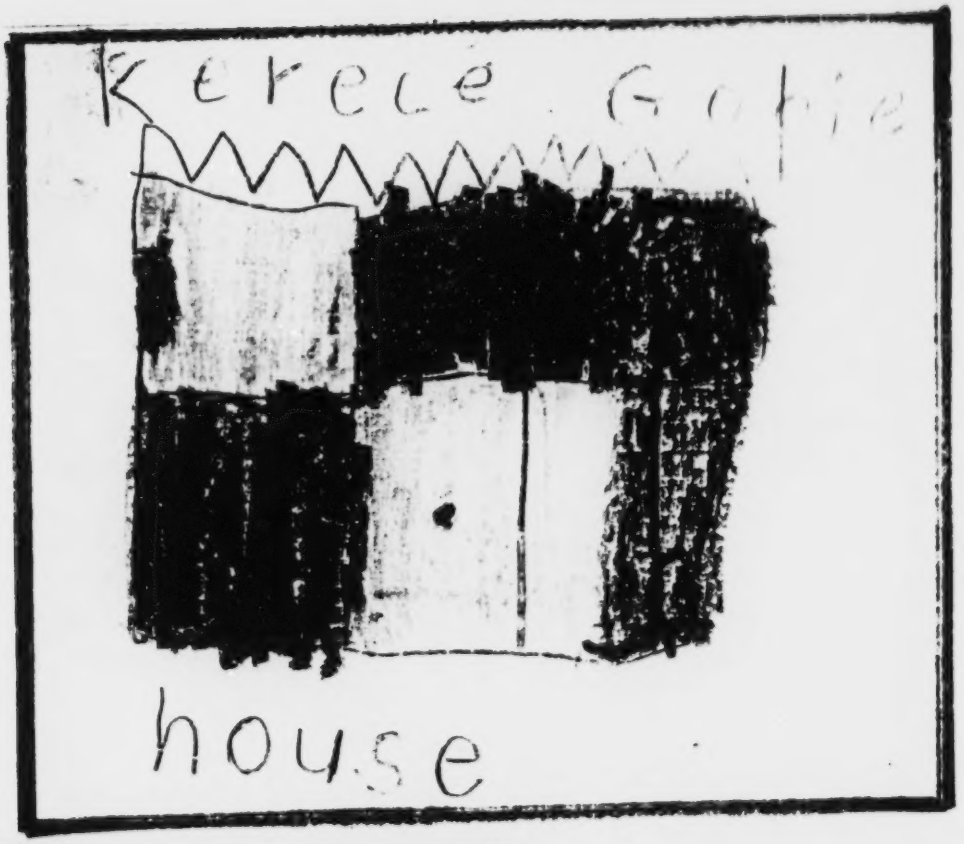
Melsha Williams

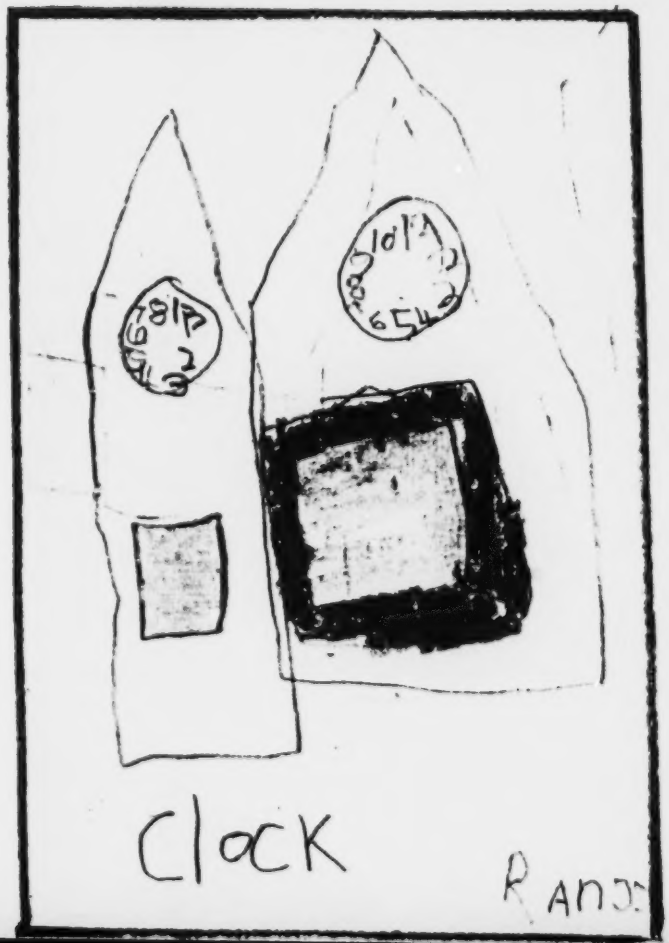
My house and a truck.

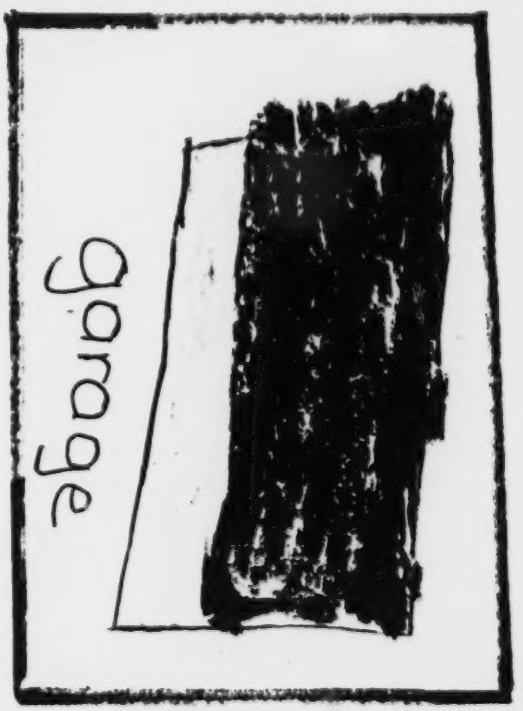
house



truck







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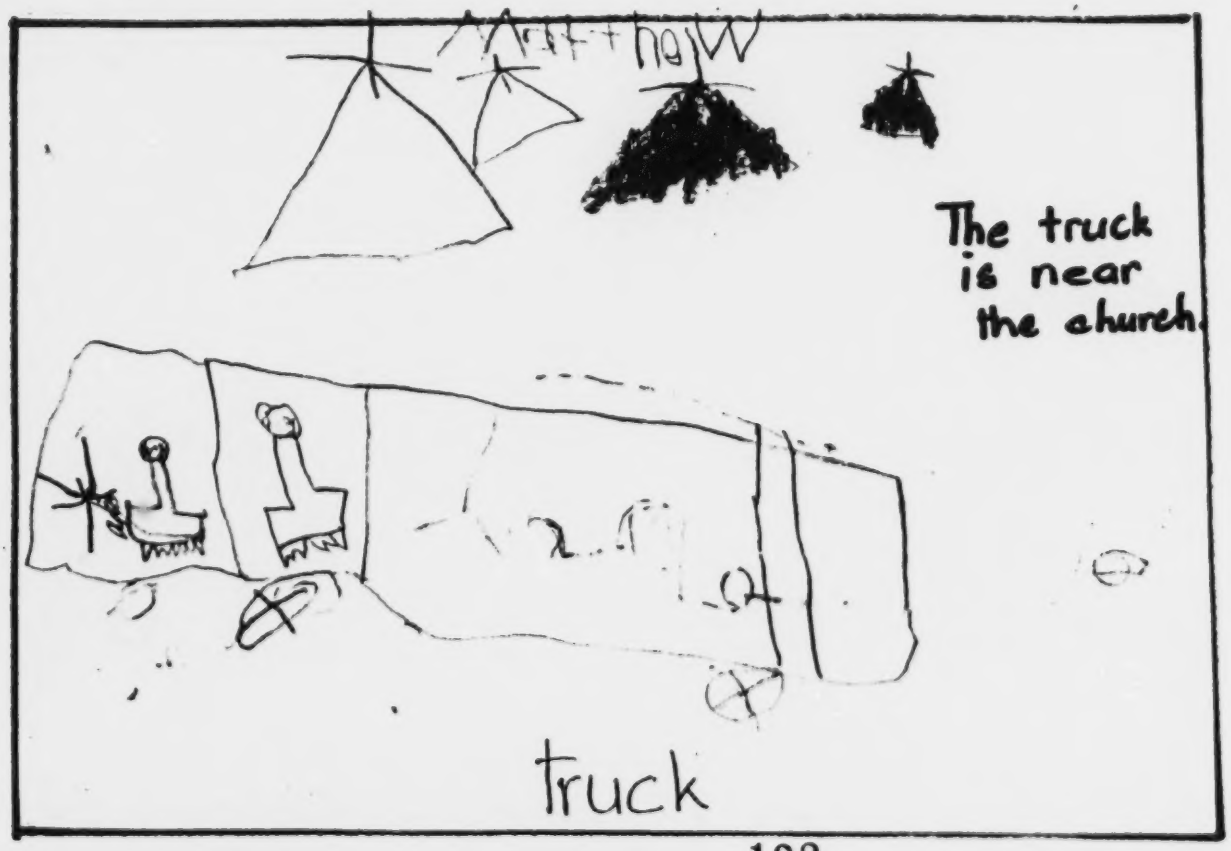
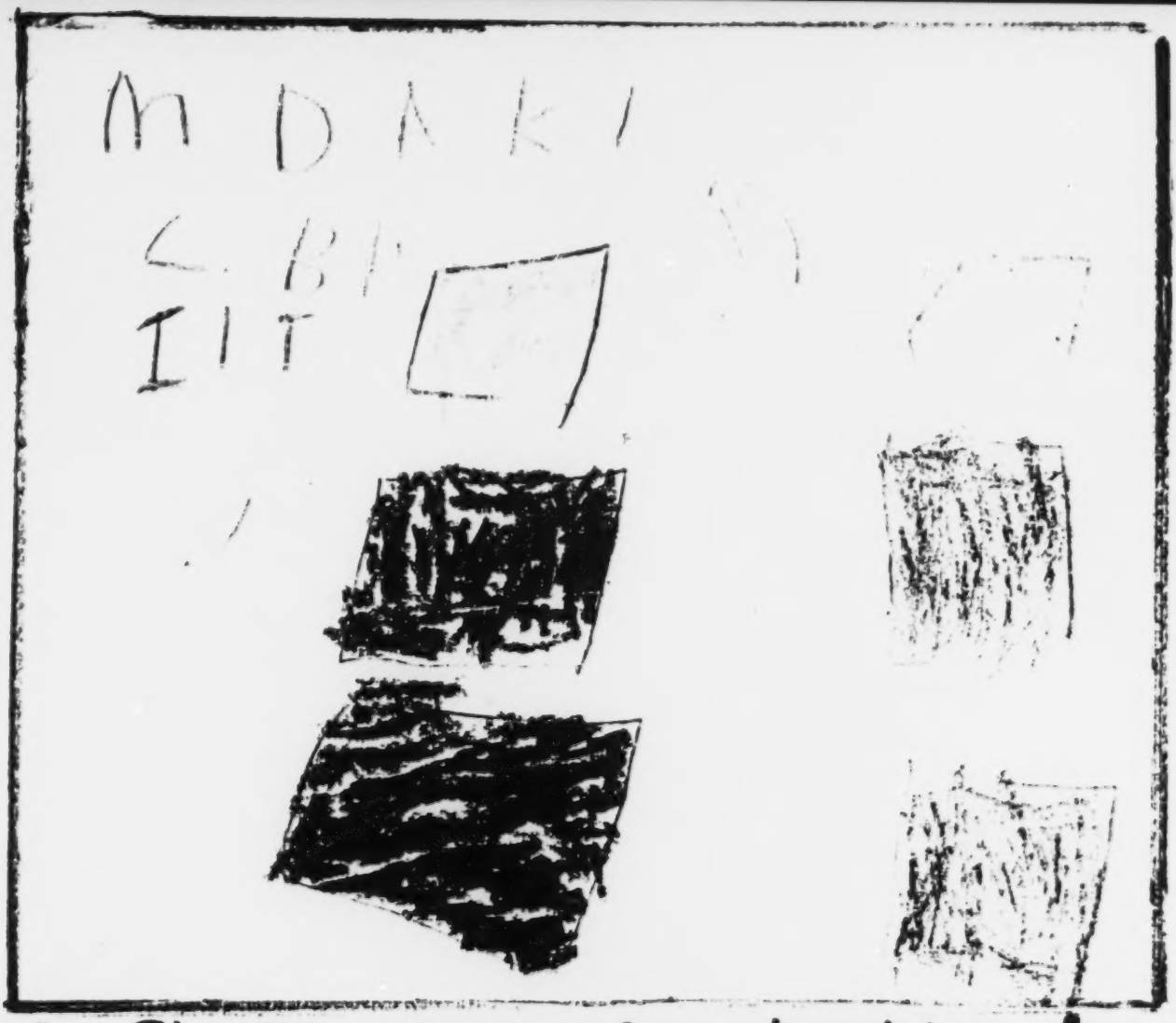
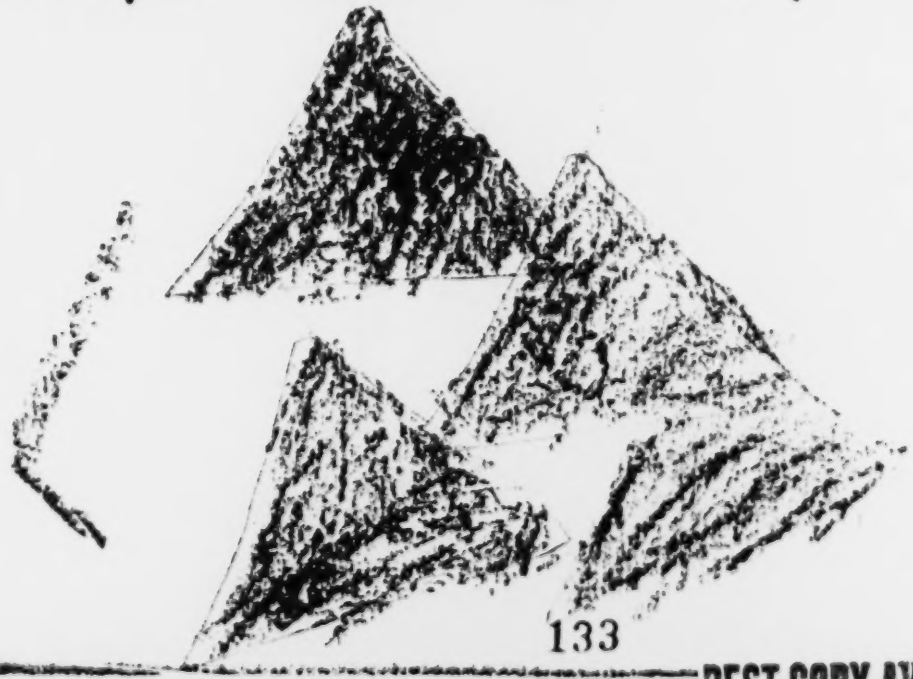
Joan Riley
The market is big.
market


The truck is near the church.
truck



Shapes drawn from templates.



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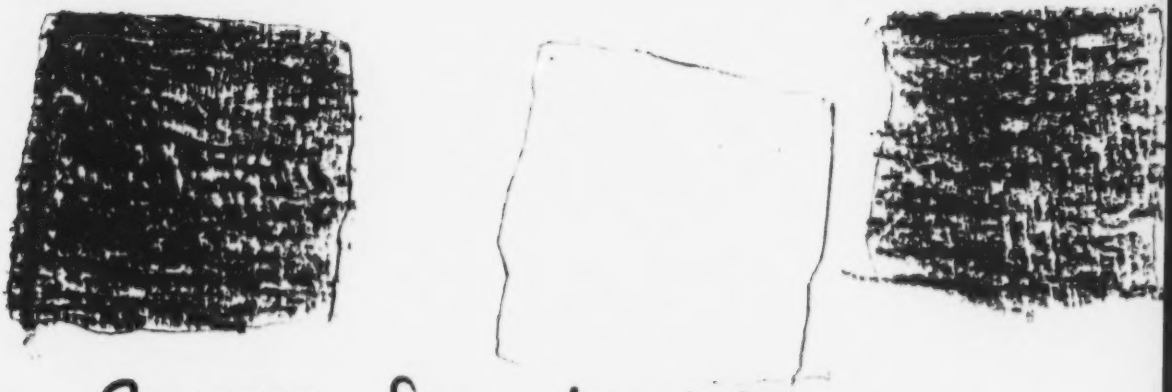
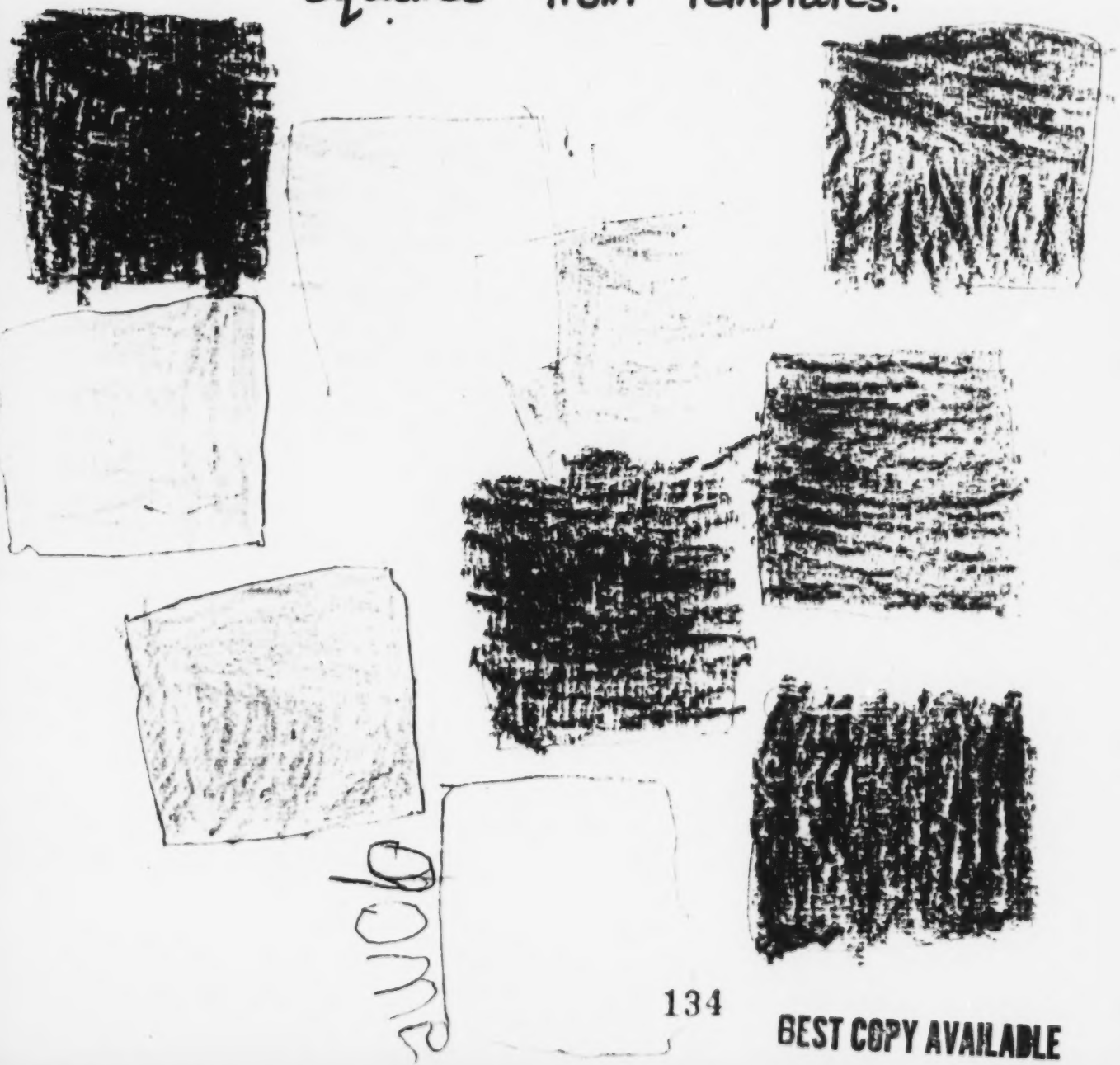


Squares from templates.



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ATTACHMENT 5

Activity Book - Some pilot samples

R A T I O N A L E

The term mathematics is widely used in our schools. At the pre-primary and primary levels, mathematics is not much more than computation. Workbooks are more and more in evidence in the classroom, but only a pencil is required to complete the exercises. All correct answers are always the same.

This activity book provides a variety of manipulative activities and much fun. There is no one right answer.

Prepared by Eugena Robinson
Project Officer
U,W,I, Bernard van Leer Foundation
North Coast Project
December 1991.

Illustrations by
Maureen Campbell

Mathematics can be Fun.

An activity book for pre-school children.

To the teacher

- These activities are designed to help the child discover relationships, develop skills and learn concepts.
- This book should be used when you work with small groups.
- Make sure that the child understands the concepts at the bottom of each page before the activities are attempted.
- The children should undertake their own activities, therefore, the results will not necessarily be the same.
- The children must get adequate practice in mastering the skill of a particular activity before they do the activity in the book.
- Before an activity is attempted please make sure that all the materials are available and clear instructions are given: Use one type of counters for each activity e.g. stoppers.
- No activity should be left out. Some children will work faster than others.
- Review the activities already done. This promotes language development, the learning of concepts and reinforcement.
- This book is designed with the pre-school children in mind - they must enjoy working in their books.
- Each activity should be completed with crayons.
- When accurate measurements cannot be done it is best to have the child say, "nearly", or "a little more than".

As many as

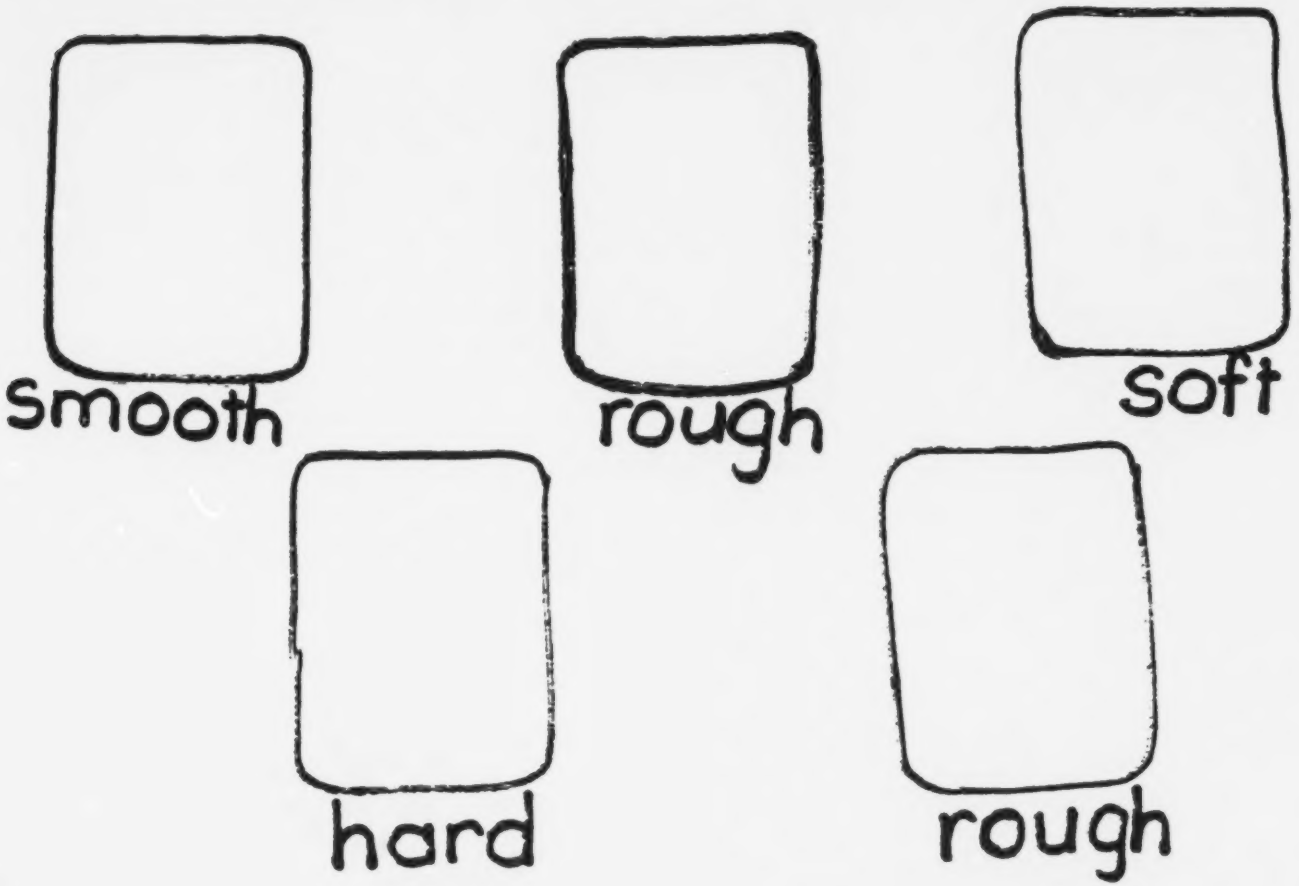
You will need: Pencil, crayons, paper, paste.

Cut out enough balls so each child can have one ball. Paste the balls on the table. Colour the children.

Feel and Tell

You will need: Sand, cotton wool, corrugated paper, juice box or any smooth paper, paste, scissors, fudge stick.

Child will paste materials or objects into appropriate boxes.



Concepts: hard, rough, soft, smooth

Skill: comparing, classifying

Sink or Float

<u>You will need</u>: Water tray, some small objects

Put the objects in the water. Draw the ones that sink and the ones that float.

Concepts: sink, float, heavy, light

Skills: observing, comparing, estimating, classifying

My foot

You will need: Paper pencil, crayons, scissors, paste, counters.

Stand on a piece of paper. Trace around your foot. Cut out the pattern of your foot. Colour your pattern.

Paste your foot pattern here.

Concept: Around.

Skill: Follow instructions.

Measure with your foot

Find something that is longer than your foot.

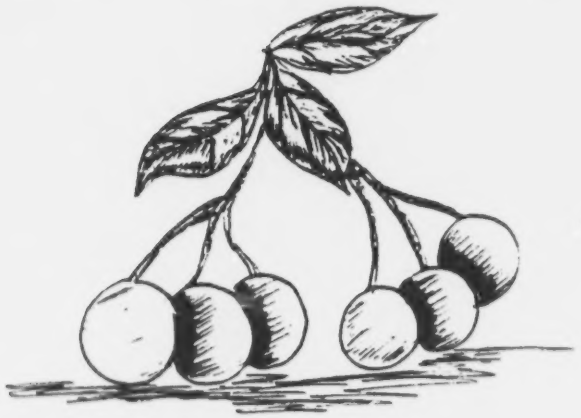
Find something that is shorter than your foot.

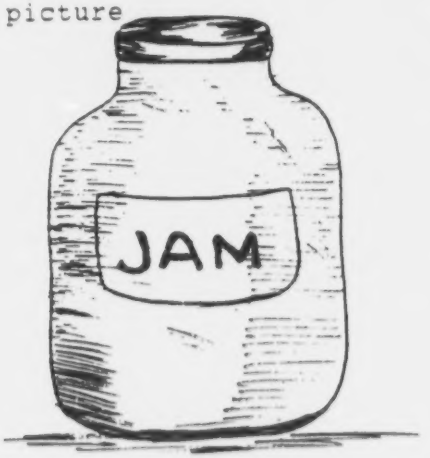
Find something that is the same length as your foot.

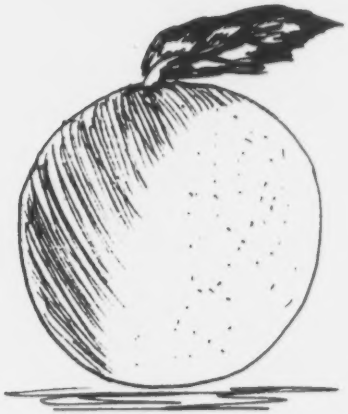
Can you find one-half?

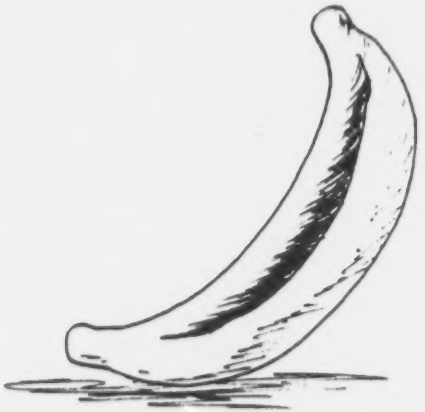
<u>You will need</u>: Pencil and crayons

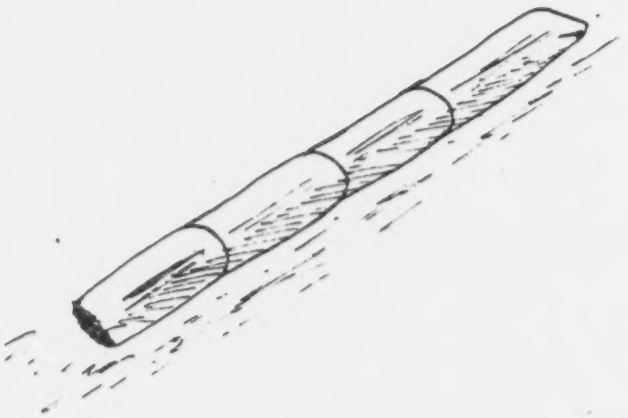
Colour one- half of each picture











Which is heavier?

You will need: Balance scale, some fruits.

Put 1 fruit in one balance pan. Put another fruit in the other balance pan. Which is heavier? Which is lighter? Draw what you see.

Concepts: heavy, light, heavier, lighter, weigh, same

Skills: estimating, comparing, classifying.

How many legs?

<u>You will need</u>: Pencil, crayons.

Three boys go walking. Count their legs. Write the numerals.

Two boys have .... legs.

One boy has .... legs.

Four boys have .... legs.

Here are two dogs. Count their legs. Write the numerals.

One dog has .... legs.

Three dogs have ...legs.

Four dogs have ....legs.

Concept: Number, more,less

Skills: Classifying, comparing,estimating,recording.

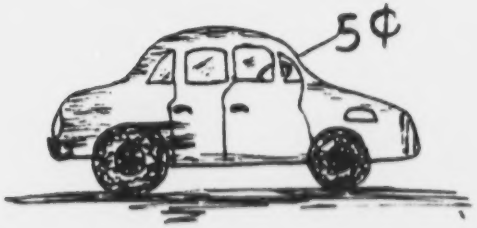
Let's go shopping

You will need: Some 1 cent coins, pencil, crayons.

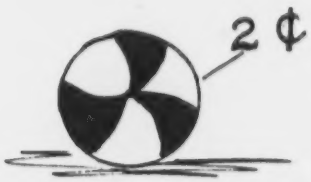
Count out the number of cents to pay for each toy.

Colour the number of cents to pay for each toy.

1¢ 1¢ 1¢ 1¢ 1¢ 1¢ 1¢



1¢ 1¢ 1¢ 1¢ 1¢ 1¢



1¢ 1¢ 1¢ 1¢ 1¢

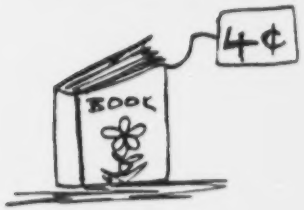
More shopping

You will need: Some 1 cent coins, pencils, crayons.

Count out 1 cent coins to pay for each thing you bought.

Draw more 1 cents to pay for the goods.

1¢ 1¢ 1¢ 1¢



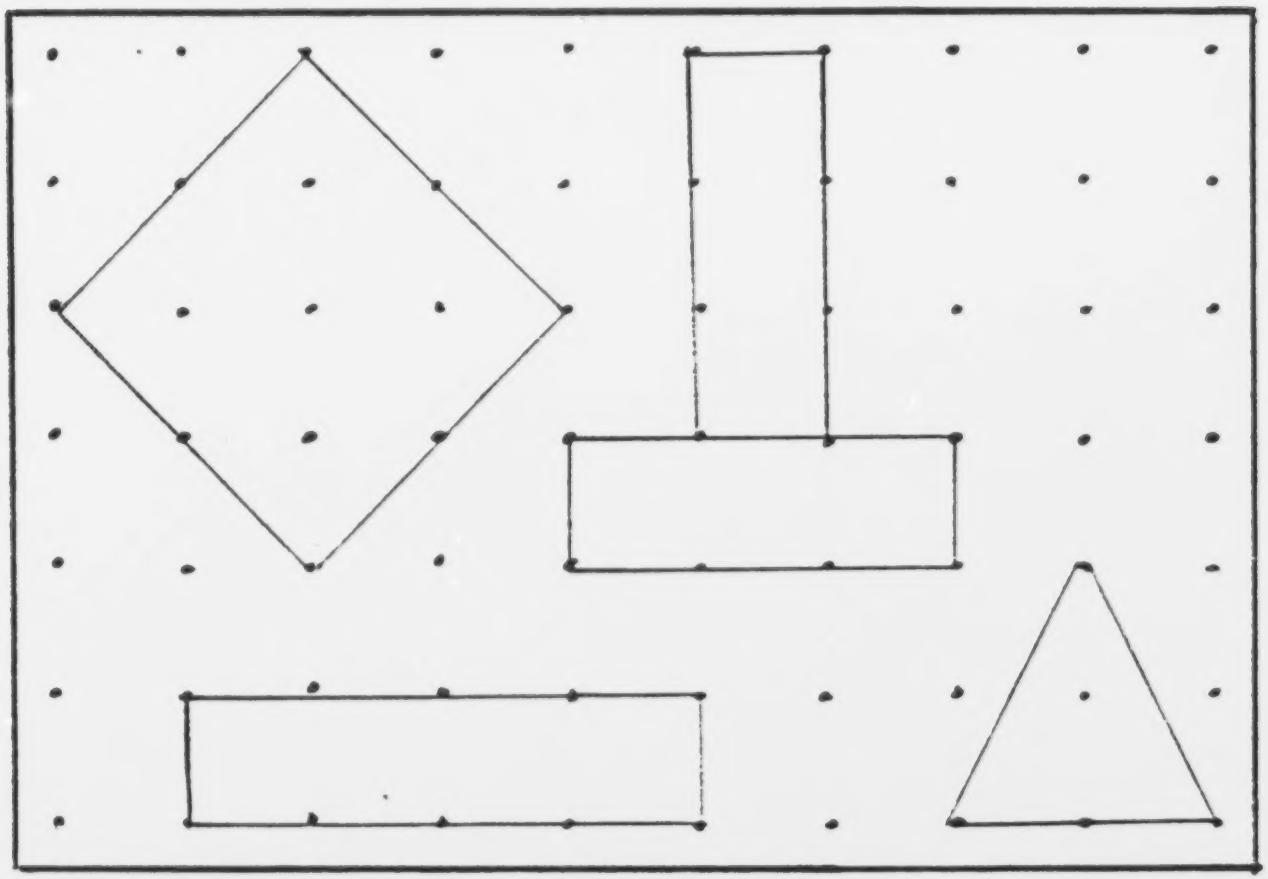
1¢ 1¢ 1¢

1¢ 1¢ 1¢

Make a shape

You will need: A geoboard and some rubberbands.

Look at the shapes in the picture and try to make them on the geoboard.



Skill: Estimating, comparing

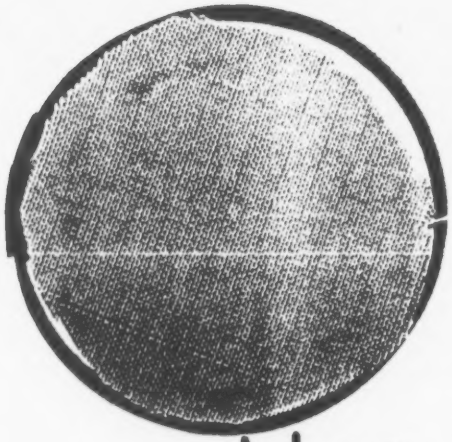
Paste a colour

You will need: Magazine, coloured paper, scissors, paste.

Tear or cut and paste coloured paper in the correct space.

red

yellow



blue

green

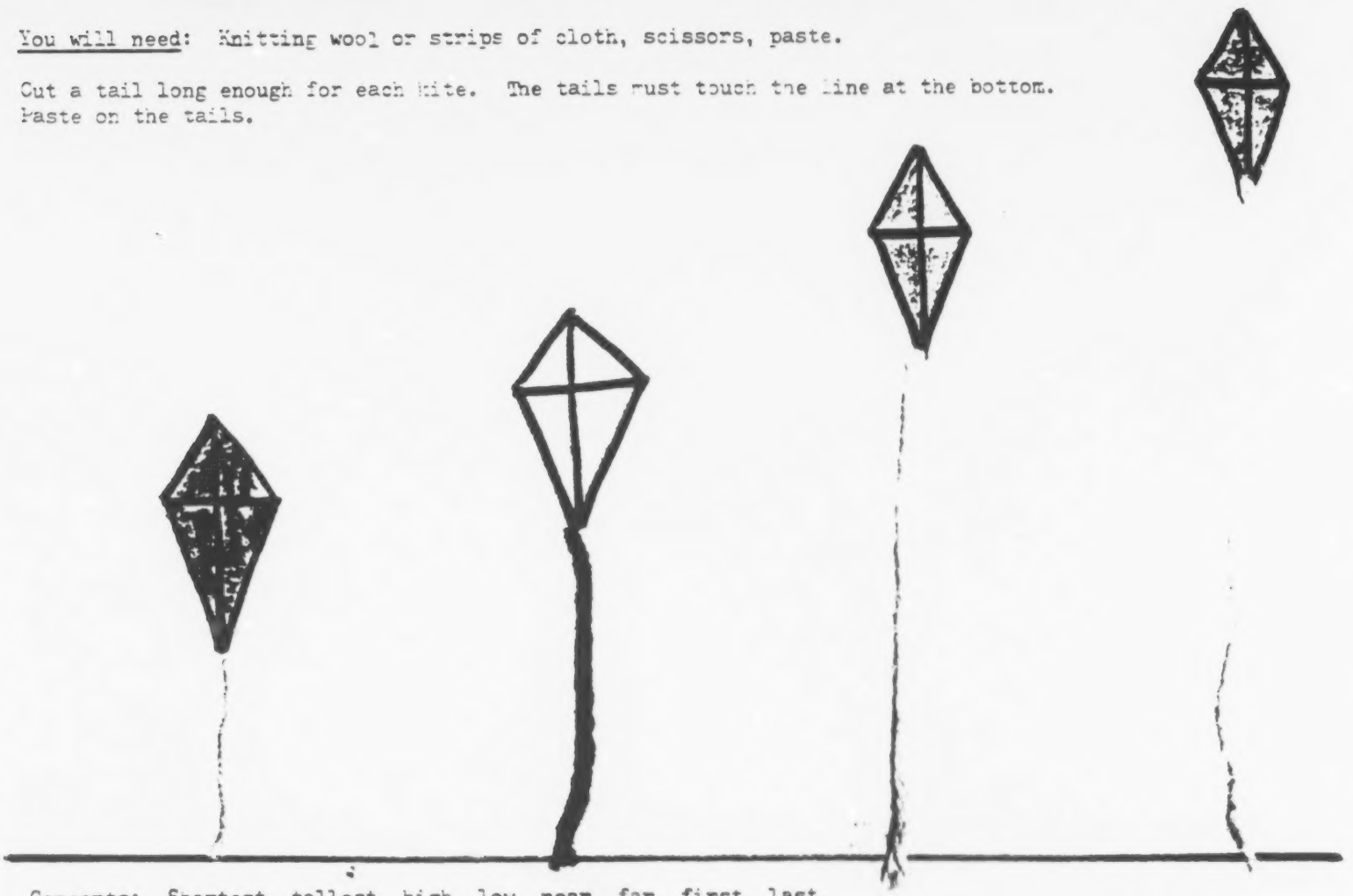
black

Concepts: Colour names

Give us tails

<u>You will need</u>: Knitting wool or strips of cloth, scissors, paste.

Cut a tail long enough for each kite. The tails must touch the line at the bottom. Paste on the tails.



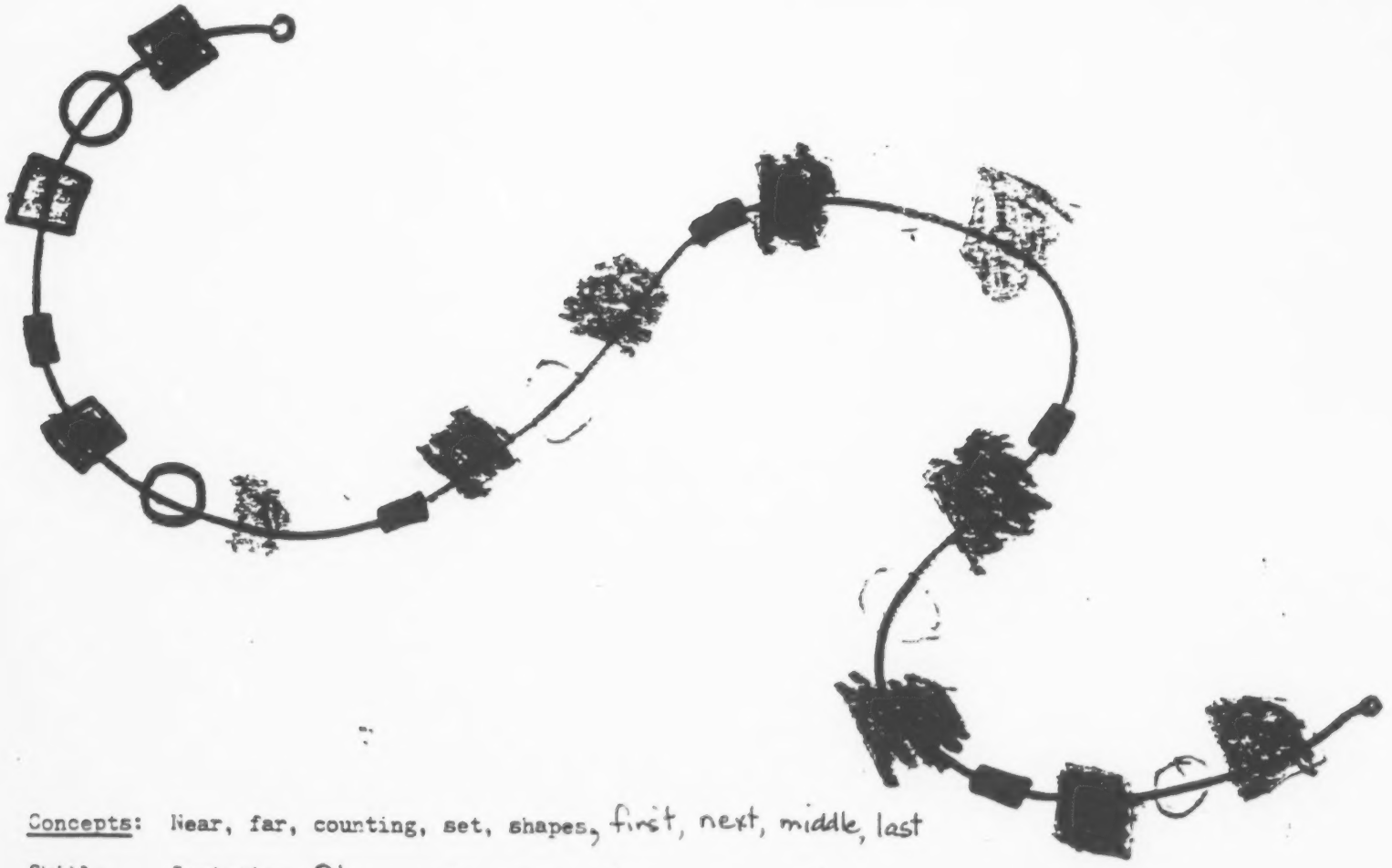
<u>Concepts</u>: Shortest, tallest, high, low, near, far, first, last,

<u>Skill</u>: Ordering / seriation, estimating, observation

Make a pattern

You will need: Pencil, crayons.

Continue to string the bead in the same pattern. Colour the beads.



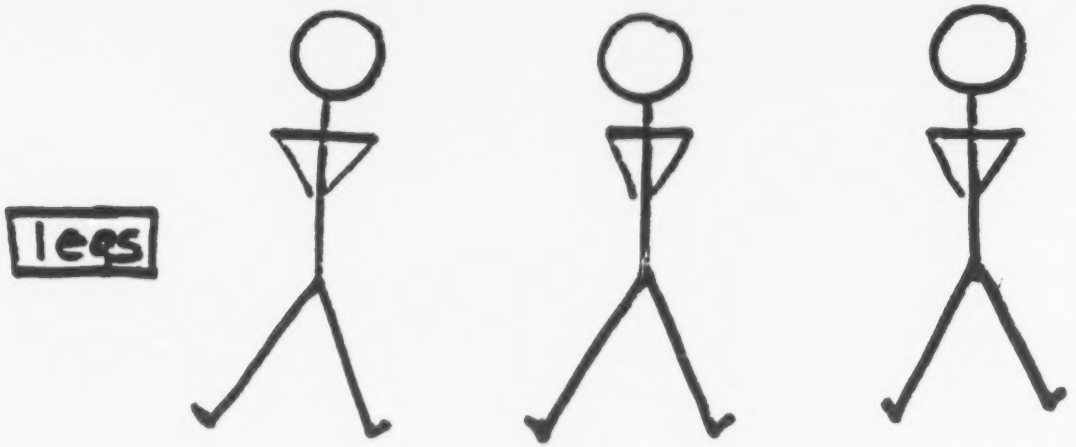
Concepts: Near, far, counting, set, shapes, first, next, middle, last

Skill: Seriation, Observation, Ordering

How many?

<u>You will need</u>: Pencil, crayons.

Here are 3 boys walking. Complete the sentence. Colour the boys.



3 boys have 6 legs.

1 boy has 2 legs

2 boys have 4 legs.

<u>Concepts</u>: Number

<u>Skill</u>: Counting, writing numerals, estimating

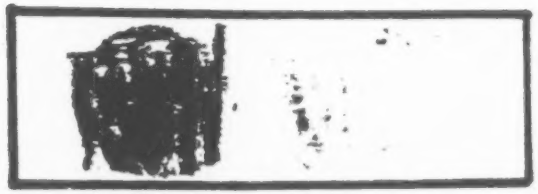
Counting

You will need: counters - stoppers, beads, stones, cubes, (only one type).

Put some counters side by side on the bars. How many counters each bar holds? Write the numeral beside each bar on the line.

.....

3 3 3



5 2 2 2

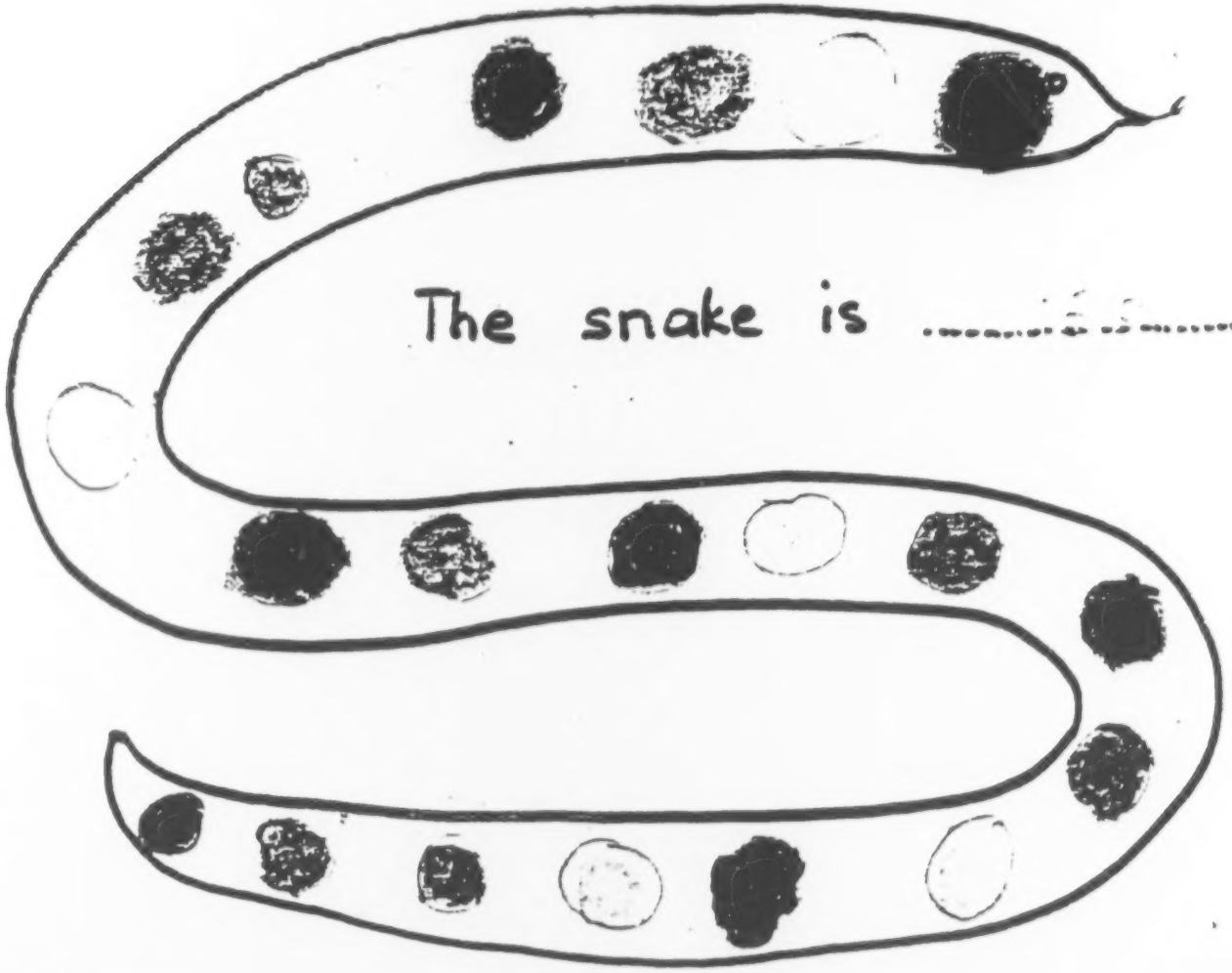
Concepts: Number, most more, least.

Skill: Counting in sequence, estimating, ordering

Counting

You will need: Counters (one type) pencil, crayons.

Put counters side by side on the snake. Count the stoppers. Write the number of counters.

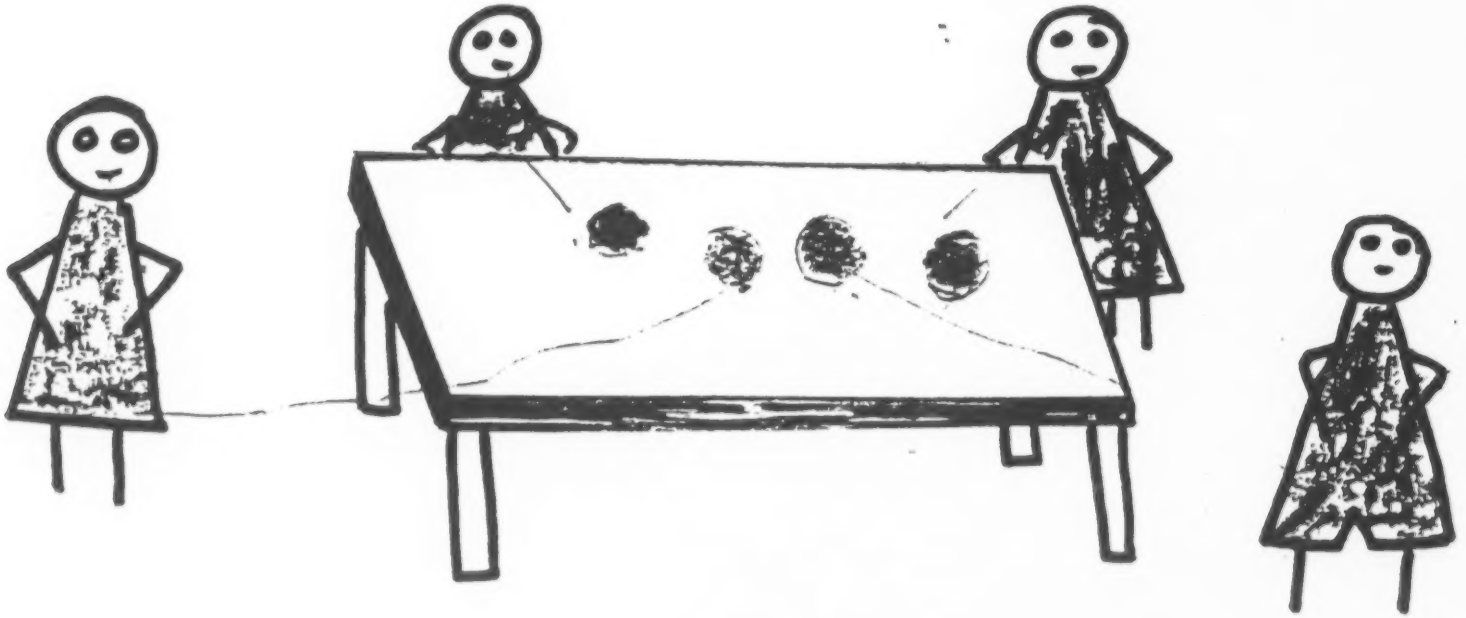


Skill: Counting

As many as

You will need: Pencil, crayons, paper, paste.

Cut out enough balls so each child can have one ball. Paste the balls on the table. Colour the children.



Concepts: Counting

Skill: One-to-one matching.

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